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FEATURE ARTICLES

Investment Castings Replace Parts Produced by Other Methods 49
Economies mark use of precision castings in place of other metal forms
Rawson L. Wood and Davidlee V. Ludwig

Highly Corrosion Resistant Spring Material Finds Varied Use 54
Unusual combination of properties suits Elgiloy for severe service conditions
Kenneth Rose

Braze Welding Cuts Costs in Fabrication of Many Products 56
Sheet metal parts and light tube assemblies readily joined by this method
C. E. Swift

New Synthetic Fiber of Interest to Industry 59
A New Materials Preview

Finishes Baked on Nonferrous Products by Induction Heating 60
Unique method quickly and effectively dries organic finishes
Frank Netschert

Materials at Work 62
Interesting examples of new materials applications

How to Select and Use Low-Melting Alloys as Production Aids 64
Bismuth alloys are valuable tools in many fields of industry
O. J. Seeds

A New Electrolytic Iron Powder 136
Particle shape plus high purity results in improved properties

MATERIALS & METHODS MANUAL NO. 62

Ceramics for Engineering Applications 69
John H. Koenig

ENGINEERING FILE FACTS

No. 197—Wrought Tin and Aluminum Brasses 85
No. 198—Nickel-Chromium-Molybdenum Steels 87

DEPARTMENTS

The Materials Outlook 3
News Digest 7
New Materials & Equipment 89
Manufacturers' Literature 154
Meetings and Expositions 164
Book Reviews 166
Advertisers and Their Agencies 176
Editorial 178

NEXT MONTH: How a War Economy Would Affect Materials Supply . . . Aluminum Die Castings for Automatic Transmissions . . . Selection and Application of Mechanical Felt . . . New Iron-Base Alloy for High Temperature Use . . . Properties and Prospects of Zirconium . . . Mash Welding of Seams in Steel . . . Precautions in Pickling of Stainless Steel . . . HEAT RESISTING CASTINGS — THEIR SELECTION AND APPLICATION (Materials & Methods Manual No. 63)

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RYERSON STEEL

The Materials Outlook

Should the military situation get no worse than it now is, there should be no serious materials shortages, with a few exceptions. . . . Nickel is in short supply, as is copper. . . . The present aluminum production is not sufficient to meet military and civilian demands. . . . The present situation has made worse shortages which existed among certain plastics prior to the start of fighting in Korea. Lifting of the copper duty of 2¢ per lb. could ease the copper supply situation. . . . At least one copper company bills the duty as an additional charge above the base price of its copper products.

> Steel should not be critically scarce unless the situation demands all out mobilization. . . . Spokesmen point out that pipelines, shipping and reserve plants which demanded steel early in World War II are now in existence. . . . Also, the present day capacity of the steel industry is considerably greater than it was in 1940. . . . Capacity now 100,563,500 tons yearly.

Current zinc-aluminum price relationship is resulting in more aluminum die castings being produced. . . . Two forthcoming products so made include automotive transmissions and sewing machine frames. . . . Many of the aluminum die casting alloys are based on the use of secondary metals.

> Labor shortages may again drive business from foundries. . . . International Harvester, for example, has started a program to convert many gray iron and malleable iron castings to parts made by other methods. . . . Cost of iron castings has doubled in past ten years. Where castings are indispensable, research programs seek to improve working conditions and modernize production methods and facilities.

As a possible replacement for steel piping there is now available a glass-fiber material which is expected to find use in the electrical, chemical and oil industries where light weight, corrosion resistance and strength are of importance. . . . The tubing could compete successfully with similar tubes of steel, stainless steel and aluminum.

(Continued on page 4)

The Materials Outlook *(Continued)*

Technical advances can be noted in the shifting materials demands of a war economy. . . . Where lead was once vital for aviation gasoline, future aviation development is expected along jet and gas turbine lines where less complex fuels are used. . . . Likewise, more attention is being paid to high temperature materials, for turbine blades and buckets.

> Magnesium still relatively plentiful, but demand can skyrocket if an accelerated aircraft program gets underway. . . . Incidentally, headway is being made in the use of magnesium die castings. . . . Many military products are to be made of magnesium due to the need for greater mobility.

Polystyrene plastics, which were rapidly moving forward to No. 1 position in injection molding, are now even more scarce due to reactivation of synthetic rubber plants which will use large quantities of styrene.

> An expected silicone rubber now emerging from the laboratory stage is reported to have a service range of from −100 up to 500 F.

Expected soon is information on plating directly on aluminum without a preliminary dip process. . . . Should the method prove satisfactory, the use of aluminum will again be boosted, although no such impetus is needed for some time to come.

> Producers of titanium metal are confident that any continuing military program will provide the stimulus to develop more fully titanium's potential uses. . . . Combined military and civilian demands could result in a lower price for the metal and thus again widen the market for this metal. . . . A second steel producer teamed up with a titanium source to exploit the metal's uses.

New England is still angling for a steel mill. . . . Latest plans call for such a mill to be located near New London. . . . Backers hope to secure Federal Government help in financing the plant. . . . Several steel companies have vetoed participation in the plan.

> Executives of metal trades associations feel that no enforced allocations will be in effect for at least six months, if at all. . . . It would take almost that long to establish a workable organization.

Idle aluminum producing equipment owned by the Government and recently sold should increase the industry's capacity by about 100,000 tons a year. . . . However, first production from the equipment is not expected before next March at the earliest. . . . Spokesmen in the aluminum industry state that much of the current apparent shortage has been caused by "panic buying," not by military needs.

News Digest

Navy Drills Smallest Hole Yet

A hole so small it cannot be seen without the aid of a high-powered microscope was drilled by a technician at the Naval Ordnance Laboratory, White Oak, Md., according to the Office of Public Information.

Believed to be the smallest hole ever drilled in metal in this country, it measures 0.0006 in. dia.—half the diameter of the average human hair and about equal in diameter to the thinnest invisible strand of silk spun by spiders. The opening is said to be about half the size of the smallest hole drilled in commercial operations.

The hole was drilled in a piece of platinum to be used in the hydraulic system of one of the Navy's new weapons. In drilling the hole the technician used a standard jeweler's lathe to which was attached the silver-like drill. Only through use of an ohmmeter could the operator tell when contact occurred between drill and metal.

Metal Powder Standards Released

Two new standards for the metal powder industry have been released by the Metal Powder Assn. One is a glossary of terms used in powder metallurgy and the other specifies tensile test specimens.

The glossary, designated M.P.A. Standard 9-50T, is composed primarily of terms not generally used in the same sense in fields other than powder metallurgy. A total of 112 terms are defined.

M.P.A. Standard 10-50T specifies a flat tension specimen and a round machined tension specimen to be used in determining tensile properties of pressed and sintered metal powders. Both standards can be obtained from the M.P.A., 420 Lexington Ave., New York 17, at $.25 each.

Magnesium Construction Planned for Military Aircraft

An all-magnesium-alloy airplane for the Air Force is reported to be in the planning stage at the Air Materiel Command's Aircraft Laboratory.

Construction of such a plane is considered practical because of the successful application of magnesium to structural components, especially in the wings of the Lockheed F-80 fighter. Made entirely of a magnesium-zirconium alloy, these wings employ a thick, un-reinforced skin as surface covering instead of the conventional stringer-reinforced, thin-skin type of construction.

New Wing Already Tested

The new type of wing has already undergone extensive static tests and has been test-flown on the F-80 for a total of 120 hr. without showing any adverse effects.

Although its skin is more than seven times as thick as that of the conventional wing, the magnesium wing is believed to be superior because few internal reinforcements are needed to prevent buckling. Only about 35% of the detailed parts and fastenings used in conventional wing construction are used in the new magnesium wing. This leaves considerably more space for fuel tanks, increasing the range of the F-80 by approximately 30%.

Magnesium Supply Not Critical

Both magnesium and aluminum alloys have been found satisfactory in the thick-skin type of construction. However, in case of emergency, aluminum would probably be harder to procure than magnesium. Aluminum is refined from the mineral bauxite whereas magnesium can be obtained economically from sea water.

During World War II, magnesium alloys had not been developed to the point where they were suitable for aircraft construction. Main drawbacks were low impact strength, and susceptibility to fatigue cracks and to corrosion under tropical marine conditions. Since then, the physical properties of magnesium alloys have been improved and satisfactory protective coatings developed.

Magnesium Used Before

Prior to its use in the experimental F-80, a magnesium alloy, coated with a zinc chromate primer and painted with a suitable lacquer, varnish or enamel, was used in the construction of the North American T-6 trainer. Protected by this coating, T-6 components made of magnesium were flown under severe climatic conditions without bad effect.

Scientists See Necessity of More Realistic Strength Tests

More realistic testing of the strength of metals is needed as a result of developments in nuclear engineering and super-sonic flight, according to two Stanford University scientists.

Prof. O. Cutler Shepard and Willis Schalliol point out that it is dangerous to use tests in air to predict the behavior of metals in other environments. It has been shown that small differences in composition of the environment produce relatively large differences in cracking and failure of various metals. These findings are expected to apply not only to nuclear engineering and high speed flight, but also to gas turbine development.

The scientists also believe that al-

News Digest

loys with improved properties for specific uses are likely to be discovered when testing is carried out under conditions which actually measure the properties of metals in the environment in which they will be used.

New Titanium Company Set Up

A new company for the production of titanium metal and titanium alloy products has been formed by Remington Arms Co., Inc., and Crucible Steel Co. of America.

The jointly-owned company, as yet unnamed, will produce sheets, rods, tubes, wire, forgings, castings and other fabricated forms. Raw material for this operation will be titanium sponge, the result of chemically treated titanium ore. It is expected that the titanium sponge will be supplied by E. I. du Pont de Nemours & Co., (Inc.), 60% owner of Remington Arms.

This is the second important corporate combination in the titanium field. Titanium Metals Corp. was established at the beginning of the year by National Lead Co. and Allegheny Ludlum Steel Corp.

Titanium-Stabilized Stainless Can Be Substituted for Type 347

Substitution of titanium-stabilized stainless steels for columbium-stabilized grades in view of the critical columbium supply was suggested by John F. Tyrrell in *Metal Progress* (July, 1950).

It appears that much columbium will have to be diverted from its use in stainless steels to the high-temperature alloys required for turbine blades in jet engines. Two methods have been suggested to alleviate the situation: One is to replace all columbium-bearing stainless by new alloys containing additions of tantalum plus columbium in equivalent amounts; the other method, often overlooked, is to encourage use of titanium-stabilized steels.

The author's comparison of the properties of titanium- and columbium-stabilized steels indicates that, except for certain corrosive conditions, there is no significant difference in engineering properties between the two materials. In aircraft and jet engine components operating at temperatures up to about 1500 F, there seems to be no difference in service behavior between Types 321 (Ti) and 347 (Cb).

In fabrication characteristics and initial cost, there are definite advantages for Type 321. Probably the most significant difference is in formability; Type 321 can be drawn deeper than 347 before localized thinning of the metal occurs.

Strength Properties of Cast Irons At Low Temperatures Summarized

A general picture of the properties of the various types of cast iron at low temperatures is provided in a paper by G. N. J. Gilbert presented before the annual meeting of The Institute of British Foundrymen in June. The author summarized available literature and presented details on the tensile and impact properties of a number of cast irons down to −150 F or lower.

Gray Irons

Roughly, he found that gray irons show a rise in tensile strength of up to 12% and a fall in impact strength of about 30% at a temperature of −150 F. Subjecting the material to low temperatures has no adverse effect on subsequent room-temperature properties. A pearlitic iron containing 2% nickel showed a 53% drop in impact strength at −190 F and little change in tensile strength. In an under-cooled iron, impact strength fell only 12% at low temperatures. A partly ferritic material showed a large fall in impact strength between −38 and −78 F.

Impact strength of cerium-treated nodular irons which contain considerable ferrite decreases rapidly with temperature, a reduction of 90% at a temperature of −150 F being obtained. A 14% rise in tensile strength was found at the same temperature.

Martensitic Irons

For acicular and martensitic irons, there is a fall in impact strength of up to 50% at −150 F. Tensile strength increases at low temperatures, the increase amounting to 18% at −160 F in one composition. Impact specimens soaked at low temperatures and tested at room temperature showed a reduction in impact strength due to a change of structure which occurred, but the values were above those of corresponding bars tested at low temperatures, i.e., strength fell at low temperature independently of changed structure.

Nickel-copper-chromium austenitic irons showed a considerable rise in impact strength with decrease in temperature toward the phase change. For one material, this rise amounted to 78% of the room temperature strength. Below phase change temperatures, impact strength falls off rapidly in the bars tested at low temperature, but remains above the corresponding values for the material returned to room temperature and tested.

Plastic-Metal Cement Developed

Development of a plastic-metal cement, useful in repairing metal surfaces, has been reported in the British *Light Metals* (June, 1950). Called "Loy Plastic Metal," the material is being marketed by Douglas Holt, Ltd.

Applied to a slightly roughened, grease-free and reasonably rust- or oxide-free surface, the putty-like compound demonstrates excellent adherence. Once hardened off, it can be sanded or filed, when it assumes the appearance of a normal metal. It can be feathered down to produce almost invisible repairs.

The material is said to be unaffected by water, gasoline and oils, and it is nonflammable. Aging characteristics of the compound are not known, but it is not suitable for service at temperatures above 212 F. All ordinary paints or cellulose can be used over the new material.

Studies Show Machining Produces Extremely High Residual Stresses

Experiments conducted by Professor Erik K. Henriksen, head of the Materials Processing Dept. at Cornell University, have shown that extremely high residual stresses are induced in the surface of a piece of metal by the action of a cutting tool, even when light cuts are taken. These results were described in a paper presented at the semi-annual meeting of the American Society of Mechanical Engineers in June at St. Louis.

The experiments included only carbon steels, and the method of cutting was restricted to dry cutting with a single point tool at low and medium cutting speeds.

Tensile Stresses in Surface

In ductile materials, the author concluded, the stresses induced are tensile in nature and are concentrated near the surface. They are closely related to the work-hardening properties of the material. They seem to be a function of the mechanical action of the tool and do not appear to depend much upon the thermal effect of the cutting. The stresses increase with decreasing carbon content and with decreasing cutting speed.

Magnitude of stresses appears to depend largely upon the shape and angles of the tool. When carbon steel is cut with a square-end tool, resultant stress values decrease steadily with increasing back-rake angle of the tool. With side-cutting tools, resultant stress values show a definite minimum for a normal-rake angle of about 18 deg., and increase rapidly for smaller normal-rake angles. They also increase for larger normal rake angles, which is contrary to what might be expected.

For a low carbon steel, the author found that the maximum stress seems to be in the vicinity of the real tensile strength at breaking, a result well in accordance with his explanation of stress formation during cutting.

Material Performance Affected

Although warping is a familiar result of residual stresses set up during machining, the author believes that a stress concentration in the surface almost of the same order of magnitude as the real tensile strength at breaking (about 100,000 psi. for SAE 1020) cannot be without other serious adverse effects upon the finished article. These stresses lower resistance to wear and corrosion and are causes of failure from fatigue or hair-line cracks. Consequently, these stresses should be adequately considered in calculation, design and manufacturing methods, particularly since they are located in the surface where calculated working stresses also usually attain their maximum values.

The author believes further work should be done on the effect of high-speed cutting and the effect of cutting fluids. He also suggests investigation of milling, broaching, drilling, reaming and grinding, and of other materials such as alloy steels for aircraft and turbine components and similar highly stressed machine parts, in addition to cast iron and nonferrous metals and alloys.

Properties of Tantalum Alloys with Tungsten, Molybdenum Studied

Results of a study of tantalum-rich alloys containing tungsten and molybdenum have been reported by Rupert H. Meyers in the British publication *Metallurgia* (June, 1950).

He found that the presence of tungsten and molybdenum in tantalum increases ultimate tensile strength, hardness, resistivity and work-hardening rate, and decreases elongation. Equal atomic additions of tungsten and molybdenum caused the same order of changes in mechanical properties, although molybdenum has a much greater effect on resistivity.

However, resistance to oxidation of the alloys is no better than that of tantalum, as temperatures above 1150 F produce a non-adherent oxide film. Furthermore, the alloys are as susceptible to gas hardening at elevated temperatures as is tantalum.

In general, small additions of tungsten and molybdenum were found to strengthen tantalum without destroy-

(Continued on page 140)

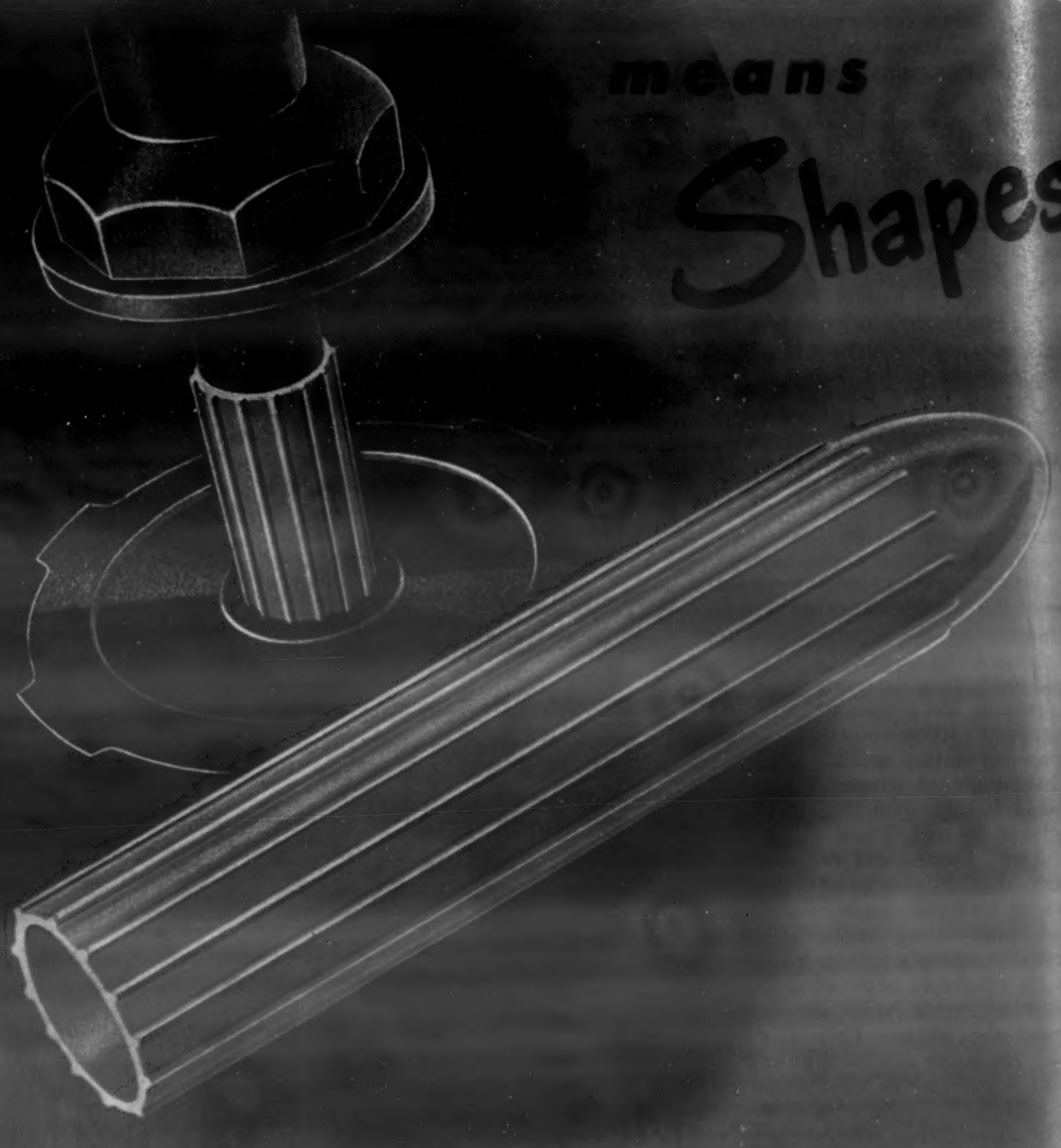
News Digest

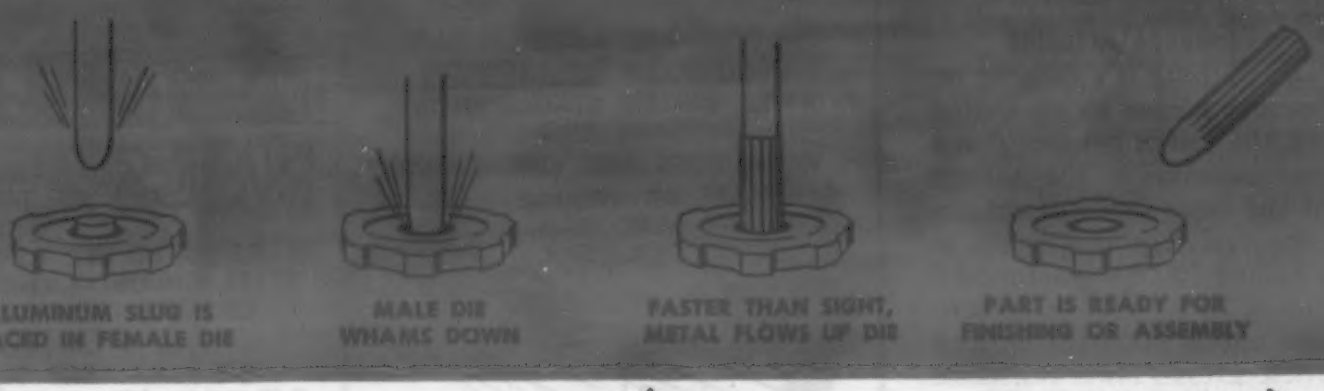
MATTER of FACT
BY EDWARD A JOSEPH
THE COST OF STEEL REPRESENTS LESS THAN 10 PER CENT OF THE SELLING PRICE OF AN AUTOMOBILE
IN 1901 THE LARGEST AMERICAN STEEL COMPANY PRODUCED 66 PER CENT OF ALL THE STEEL THEN MADE IN AMERICA.....
TODAY..... IT PRODUCES ONLY 33 PER CENT
THERE WERE 1,660,000 BUSINESSES IN THE UNITED STATES FIFTY YEARS AGO:
TODAY THERE ARE APPROXIMATELY 4,000,000 AN AVERAGE INCREASE OF MORE THAN 40,000 PER YEAR
NAILS ARE ONE OF THE CHIEF PRODUCTS FABRICATED BY AMERICA'S STEEL INDUSTRY....THE LARGEST OF THEM WEIGH NEARLY 2 POUNDS THE SMALLEST NUMBER 95,000 TO A POUND....

ONE-PUNCH PRODUCTION

means

Shapes





ALUMINUM SLUG IS PLACED IN FEMALE DIE

MALE DIE WHAMS DOWN

FASTER THAN SIGHT, METAL FLOWS UP DIE

PART IS READY FOR FINISHING OR ASSEMBLY

Here's what we mean by "One-Punch Production"

Materials & Methods
SEPTEMBER 1950

Precision Investment Castings Replace Parts Produced by Other Methods

by **RAWSON L. WOOD,**
President, Arwood Precision Casting Corp.

and **DAVIDLEE V. LUDWIG,**
Consultant, Director of Research, Vacuum Casting Corp.

Significant economy and improvement in product performance have marked the substitution of precision investment castings for other metal forms in many applications.

• PRECISION INVESTMENT castings of many different alloys can frequently replace components previously produced by other metal-forming techniques, and thereby bring about improvement in product performance and savings in original part cost and production processing. Within the size range currently handled in investment casting, no alternate process or combination of processes offers the dimensional precision, freedom of alloy selection, and design intricacy obtainable by this method.

Most of the parts currently being investment cast are modifications of designs of small machine components which were previously produced by other methods. Except for specialized products in the aircraft jet engine field, nearly all of the investment castings have been or could be produced otherwise. Usually, however, when the part is specifically designed for the process, the economies of cost, mass and design are all superior to those obtainable by the best combination of alternate approaches. Therefore, an increasingly large number of parts is being designed specifically for investment founding. This is particularly true in the aircraft industries where design staffs have recognized the potential of the process for nearly a decade.

The process is not and will probably never be directly competitive with die casting, screw machine forming, stamping or any other rapid metals fabrication process, when the products are of such design that these alternates produce adequate parts. But for products manufactured in small quantities, the overall economics and the more flexible production techniques used tend to favor investment casting, even of simple parts of machinable materials.

The largest volume of investment casting business today involves operations which consolidate numerous small sub-components previously produced by such operations as stamping, forging, turning and die-casting as well as operations in which the change to the investment process has permitted important design modifications inefficiently accomplished by the prior arts. Some brief case histories will serve to illustrate typical design or production problems where investment castings have competitively resolved the difficulties.

Radar Part

Both an important reduction of cost and a considerable improvement in functional worth has been realized by investment-casting various complex assemblies for use in radar equipment. One such example is the microwave mixer and guide body casting shown in Fig. 1.

These parts were formerly assembled from more than 20 components by a costly and very inadequate furnace brazing operation using silver solder. This operation required the

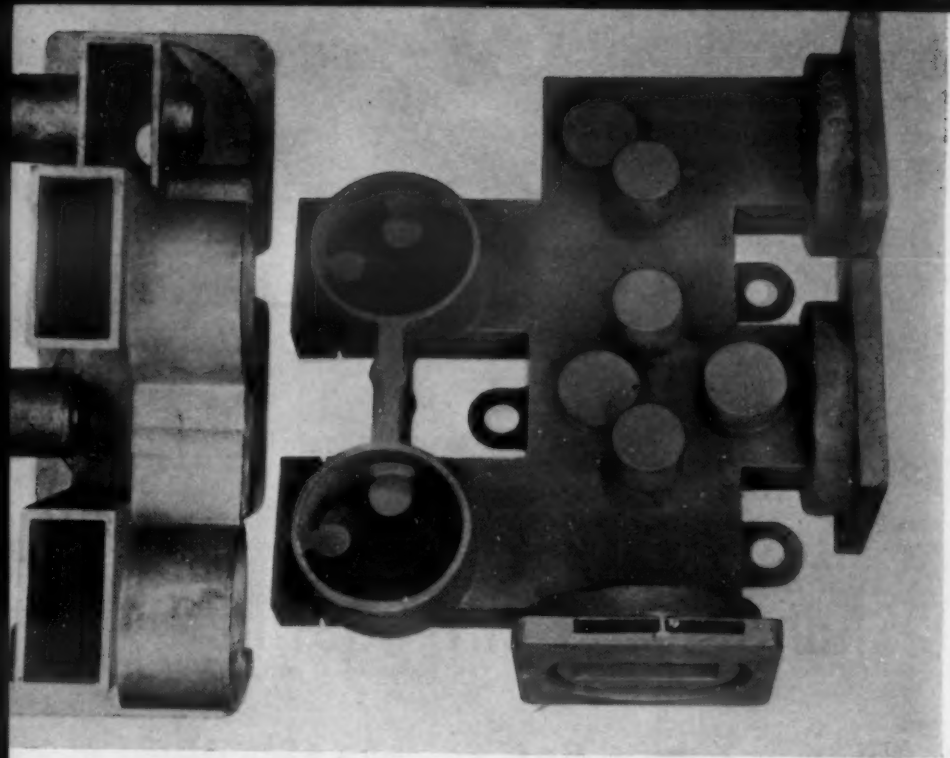


Fig. 1—Microwave mixer used in radar equipment.

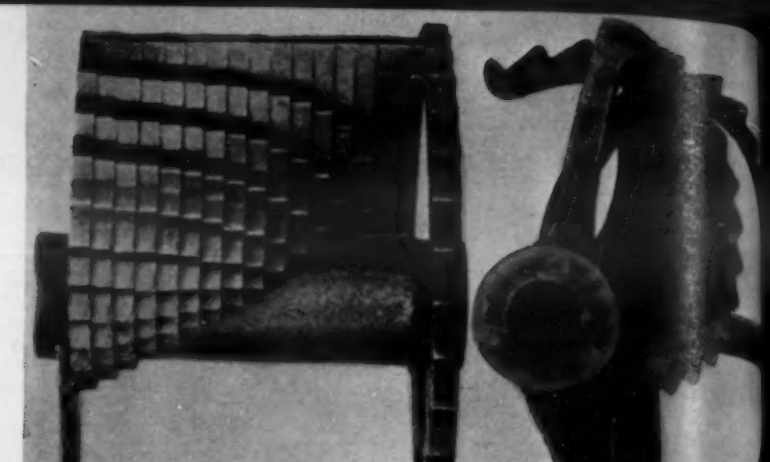


Fig. 2—Business machine indexing cam.

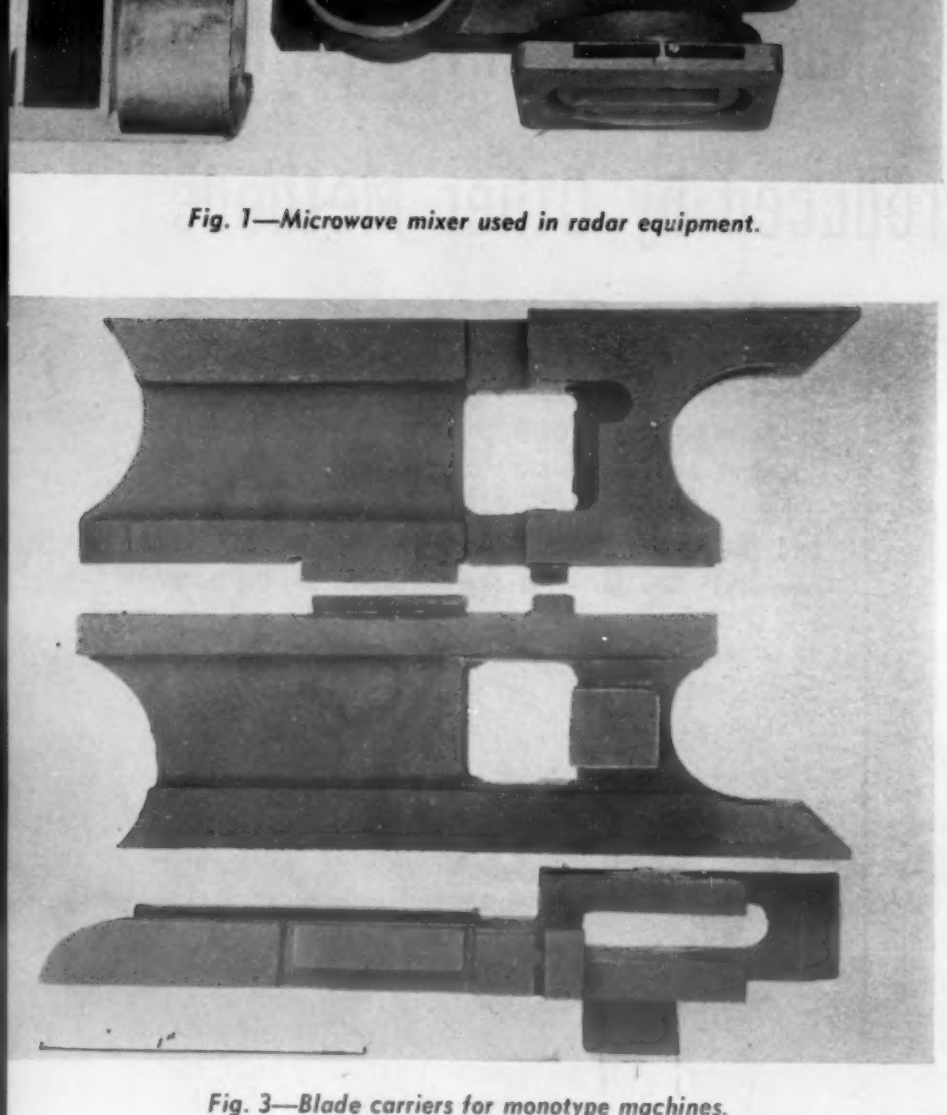


Fig. 3—Blade carriers for monotype machines.

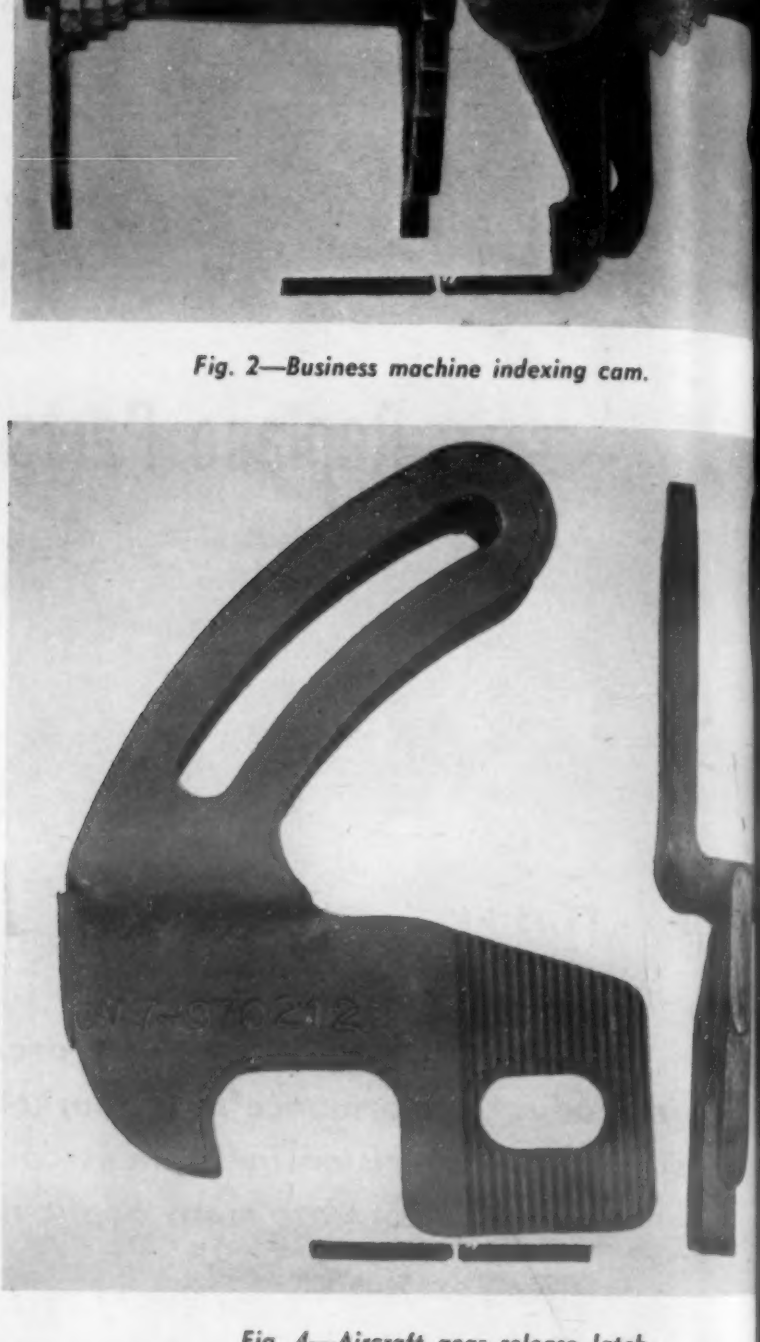


Fig. 4—Aircraft gear release latch.

use of costly precision jigs for holding the numerous wave guide channels in alignment. Production of off-dimension parts was high and the life of the jigs short. The important electrical field characteristics of the unit were not ideal due to the differentials in the flux fields imparted by the various resistivities and conductivities encountered in the silver soldered joints and body components. Each assembled part cost more than $350.

Through the substitution of investment cast aluminum, type 356T6, the performance characteristics were improved and cost substantially affected. The size of the part, combined with the thinness of the walls and the required tolerances, required the use of silicon-magnesium-aluminum, the most castable aluminum alloy available. The casting walls were held to overall thickness deviations of less than 0.003 in. and the passages were held to alignment and angularity to within ±0.002 in. No draft was permissible in the casting. Exceedingly accurate, multiple cored and multiple parting wax die equipment was required which, combined with special cooling and storing jigs for the wax patterns, permitted production of such large castings to the required limits.

The tools were relatively costly, compared with usual die costs for investment patterns, but total tooling was less than 20% of the previous tooling requirements. Barring major product redesign, the present tooling is permanent for all practical purposes. Minor product redesigns may be incorporated in the basic tools as they have already been upon occasion with minimum cost. The finished, machined casting costs approximately $75, of which $30 represents the foundry cost.

Total economic gain in this instance is more than the difference between the original part cost of $350 and the present cost of $75. The substantial reduction in tool capitalization, combined with the indirect advantage of release of precision machine tool time previously required for making the sub-components of

the original parts as well as the replacement jigs and fixtures, represents a real economic gain.

Business Machine Cam

The indexing cam (see Fig. 2) for a business machine illustrates another, different type of problem, in which the substitution of investment castings for assemblies of stampings and screw machined parts resulted in several design and performance advances plus a substantial cost reduction. The cam formerly was pinned and brazed together from 18 stampings and a screw machined part. Each part had to be hand filed to make it functionally satisfactory after the assembly operation. It was made of soft brass to facilitate stamping, resulting in a relatively short life for the parts. The inertia resulting from the part being badly weight-stress designed imposed a considerable load upon the drive motor and gears. Each part cost approximately $30.

The investment casting of silicon brass more than trebled the strength and wear resistance of the part. Furthermore, the good foundry properties of this particular alloy permitted complete redesign to eliminate excess mass. As a result, the casting now weighs 40% less than the original assembly and the functioning of the machine in which the piece is used has been improved. No hand filing or fitting is required in assembling the cast parts and all are completely interchangeable. After a finish reaming operation, the finished piece price is about $3, or 10% of the original cost.

Blade Carrier

Cost of materials and the difficulty of removing surplus stock often place a prohibitive premium on alloys which otherwise would offer the best functional advantages. The blade carrier for a Monotype machine (see Fig. 3) illustrates a part design which involves extensive stock removal by many different machine operations when the part is hogged from solid stock or even produced from rough forged blanks. The volume of metal to be removed and the number of different setups required to remove it have previously prevented making the part from any other than free machining carbon steels. This type of machine component graphically illustrates the myriads of similar units whose volumetric inefficiency in removal of metal surplus from milled solids limits the selection of ideal alloys for best functional design.

Requiring over 20 milling, contouring, slotting, broaching, grinding and finishing operations, this finished part previously represented only 35% of the initial metal volume when made from solid bar stock. The SAE 4140 steel investment casting, however, requires only finish grinding for completion. The life of the part is improved by the use of the better material and the cost reduced 65%, which is identical to the percentage of metal saved.

Aircraft Parts

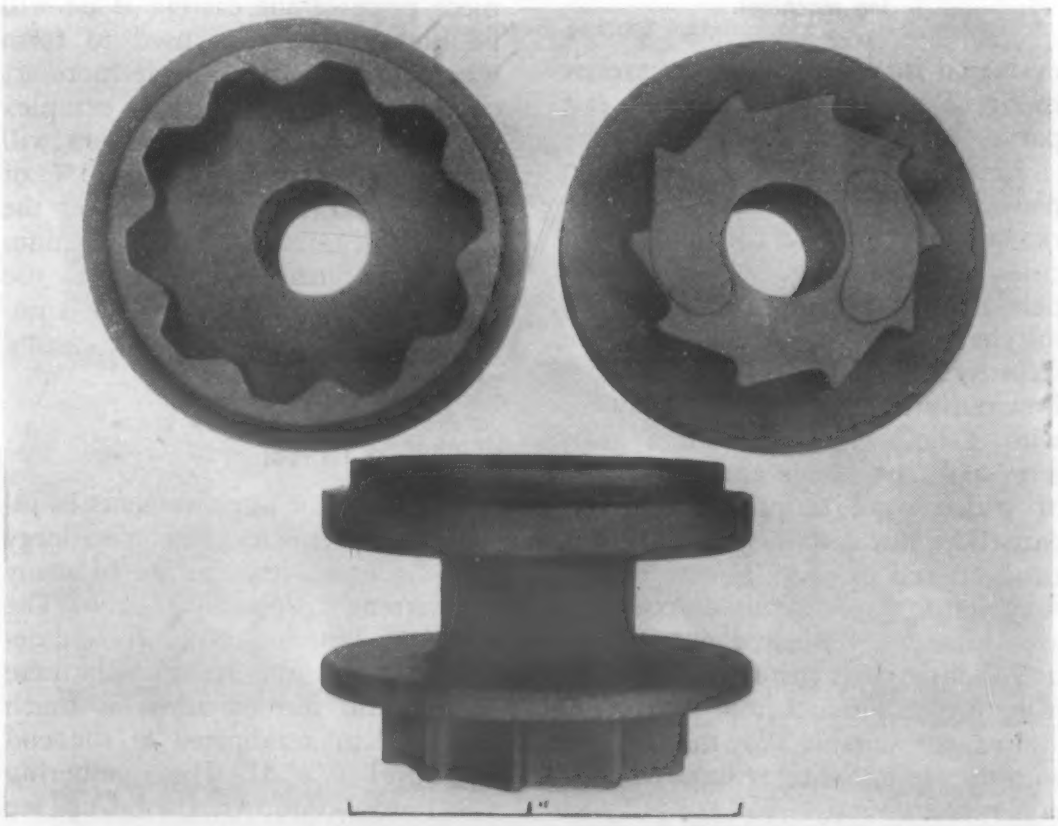
Several aircraft manufacturers are designing many small ferrous and nonferrous parts, formerly machined from forged blanks, to be investment cast. The aircraft gear release latch shown in Fig. 4 embodies good casting design. All functional details are incorporated and the part is used as-cast and finished by the foundry. The side slots are held to ± 0.005 in. and the main slot is held to $+0.005$ in. After casting, the nose of the release latch is selectively hardened by case carburizing to a Rockwell C 60. All aircraft quality controls must be met, including radiographic, magnaflux, magnetic particle and all usual physical and chemical standards.

Use of SAE 3120 facilitates production of tough, detailed, easily-case-hardened latch castings. Occasionally some of the parts fail due to the stresses set up in the heat treatment cycle. This occurred in the gear release latch in Fig. 4, which has a noticeable crack. Such pieces, of course, become foundry scrap. But the parts which pass all control standards possess high wear resistance where needed and are still so tough in the main body of the latch and in the fork section that these projections may be reverse bent over 180 deg. without fracture. The friction serrations on the release thumb represent a detail which can be easily cast, but which would be comparatively costly to machine in. These parts have not been produced, as designed, by any alternate method. The cost analysis of probable machine sequences to make the part from solids or forged blanks indicates that an approximate saving of $6.50 is obtained by casting the part. Finished and heat treated, the casting costs approximately $3.50.

Ratchet-Gear Unit

However, the ability to make major cost reductions should not be the sole, or even the most important, ground for using the investment process. Often the performance improvement which can result by correct redesign of parts for casting will justify the change, even though there may be no immediate per piece price advantage. Often, too, the change is warranted when the price is higher, in order to obtain the advantages of casting more suitable materials to more functional shape. All factors—functional efficiency, tooling costs, product appearance and performance—must be

Fig. 5—Business machine ratchet-gear units.



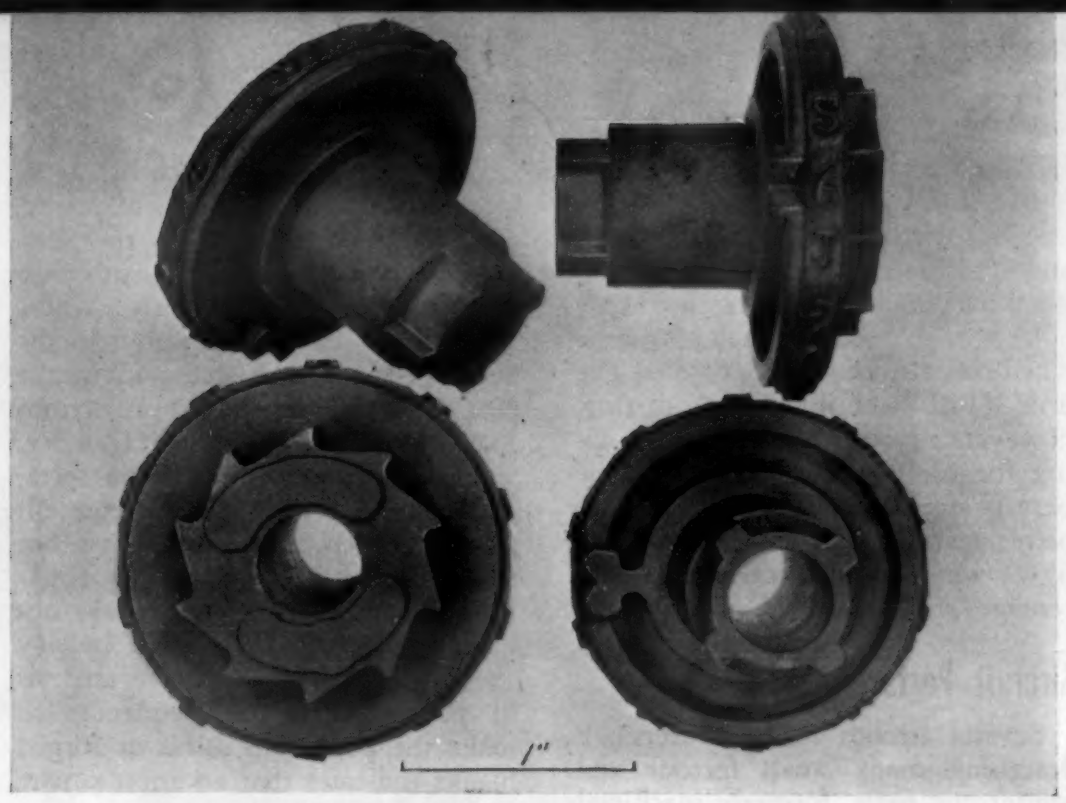


Fig. 6—Numbering wheels.

Fig. 7—Looper castings for industrial sewing machines.

evaluated in determining the precise merit of using the investment cast part.

Although the use of a cast part in place of the riveted assembly in the ratchet-gear unit for a business machine shown in Fig. 5 resulted in a per piece reduction of only 10%, the change was amply justified by the improved product which resulted. Previously this unit was assembled with 3 hollow rivets from a gear, face, staff, and flange and ratchet, all of which were stamped or turned parts. The low carbon steel casting is stronger and is used as-cast except for reaming the center hole. Assembly operations are eliminated and production tooling costs materially reduced. If additional product improvement is desired, any suitable alloy may be cast with the same tooling without significant cost increase.

Parts within the limits of size of the investment process, those which are of low melting alloys of aluminum, copper or magnesium, and those which are commercially die cast must be given careful consideration in selecting the proper production method. There are many types of parts so simple in design and function and required in such volume that there is no possible competitive comparison between processes. There are many others, however, where either the design, quantity or metallurgical quality considerations require the use of investment molding for best production economy. Where comparatively limited quantities of castings are to be used, the relative tooling costs often are sufficient to justify using the investment process, even when the per piece price of the casting alone will be higher. The dies used to form wax patterns may be made more accurately to impart far more complex design details. Yet they seldom will cost more than from 10 to 25% of the die charges for die casting the metal. Consideration of maximum economy of mass often requires use of a heat-treatable alloy which is unobtainable by the pressure die casting process.

Numbering Wheel

Recent major improvements in investment chemistry and metallurgy have facilitated the casting of many high strength, low alloy steels. The degree of dimensional control and design intricacy obtainable with these highly fluid ferrous alloys is much greater than anticipated at the end of World War II. The numbering wheel castings of SAE 4140 steel (see Fig. 6) illustrates a type of part which was recently considered castable only in the most fluid nonferrous cuprous alloys. The raised and recessed numbers were details which were not considered practical for production in steel. But the advance of ferrous casting control in at least one major foundry has reached the point where now the more fluid steels are preferred for casting fine details.

The part was originally made by brazing together 7 components which included the hub, sprocket, engraved wheel, edge and center rings, advance cog and the end sprocket or clutch section, each of which was formed separately by stamping, turning, milling, forming and engraving. Investment casting requires only reaming, facing and a grinding operation for completion of the job. The casting cost of about $2 is less than half the former engraving costs.

Sewing Machine Part

Frequently, when a part is to be converted to the investment process from another manufacturing method, the new specification requires the same alloy. Although it is always possible to cast the alloy mentioned, often better castings would result if the foundry suggestions on preferred alloy were considered. Most designers overlook the fact that the cast properties of any given material differ considerably from the milled, forged or otherwise worked properties. Too frequently the original materials specification requires an alloy possessing good machinability as the prime requisite, because large volumes of metal have to be removed from the raw stock. However, when a part has been correctly redesigned for investment casting, machinability should be a negligible consideration. The alloy chosen should either be selected for best functional properties in use or, if these are not affected by the alternate materials which might be used, the metal chosen should be the one most suited for casting.

The use of an alloy steel in place of a straight carbon steel is usually overlooked, because of its higher cost, by the designer turning to investment casting. But this factor is completely offset in the final cast product if the alloy metal is more castable than the less costly base. The industrial sewing machine looper casting in Fig. 7 illustrates this point. It originally was machined from forged blanks of SAE 1020 steel, the required

operations including 5 contour milling operations, turning and milling the shank, grinding the points and finishing.

The first castings were specified in the same metal, but the surface finish of the parts and the rendition of detail were not satisfactory due to the poor fluidity of molten 1020. The foundry then recommended changing to SAE 3120, with the result that foundry scrap was more than halved and all parts produced were smoother and more accurately detailed. The parts are finished by grinding the point and polishing the thread surfaces while the looper section is carburized to about Rockwell C 60 to resist abrasion of the thread. The low alloy parts cost no more than the castings of 1020 and permit a part saving of approximately 30% per piece.

Roller Cage

The flexibility of the investment process and the low tooling costs permit runs of comparatively limited quantities of fairly complex parts such as 88-8-4 bronze roller cage castings shown in Fig. 8. Several different designs of these items are produced in quantities from a few hundred to more than 5000. The slots are held to 0.004 in. and overall dimensions are close enough so that the pieces can be used without machining. Although the per piece price does not represent any significant saving, the low cost of tooling for casting production and the release of machine tool capacity are the determining factors in making these parts in investment.

Gas Cap Lock

Absence of the machinability problem when properly designed castings are made in investment permits use of the most suited alloy for best performance. The gas cap lock castings for aircraft (see Fig. 9) was originally designed to be hogged from forged stainless steel. This proved to be economically impossible because of the problem involved in forming the slot in the half-inch thick section. The part was then made of a machinable low alloy steel, but the corrosive effects of the aromatic aircraft fuels made this alternative unsafe. The problem was finally solved successfully by redesigning the piece slightly to make it suited for investment casting and using Type 302 austenitic stainless steel. Per piece price of the casting is about $1.50, a very low figure when compared to that of the machined low alloy steel piece. The slot is used as-cast; finish operations are performed by grinding a few close tolerances.

Minimizing the removal of metal by machine operations is one of the most important economic factors in investment casting. This benefit may be also obtained by alternate processes such as die-casting or powder metallurgy when the materials to be used, metallurgical properties required and designs are suited to these alternate processes. However, the ability to cast all castable alloys to precise, intricate outlines is unique to the investment process. Correctly designed investment castings should provide no more than 0.020 in. of stock on surfaces to be finished by machining. Usually the tolerance will be in the order of 0.010 to 0.015 in.

The elimination of the factor of materials waste and the cost of removal of the waste allows the designer to select the alloy most desired for maximum efficiency of his intended product. For example, among the ferrous alloys, the high alloy steels tend to be more suited for investment casting than the low alloy or straight carbon steels. Final choice of materials should be made with the factor of castability in mind and previous limitations of machine tool handling should be almost wholly disregarded.

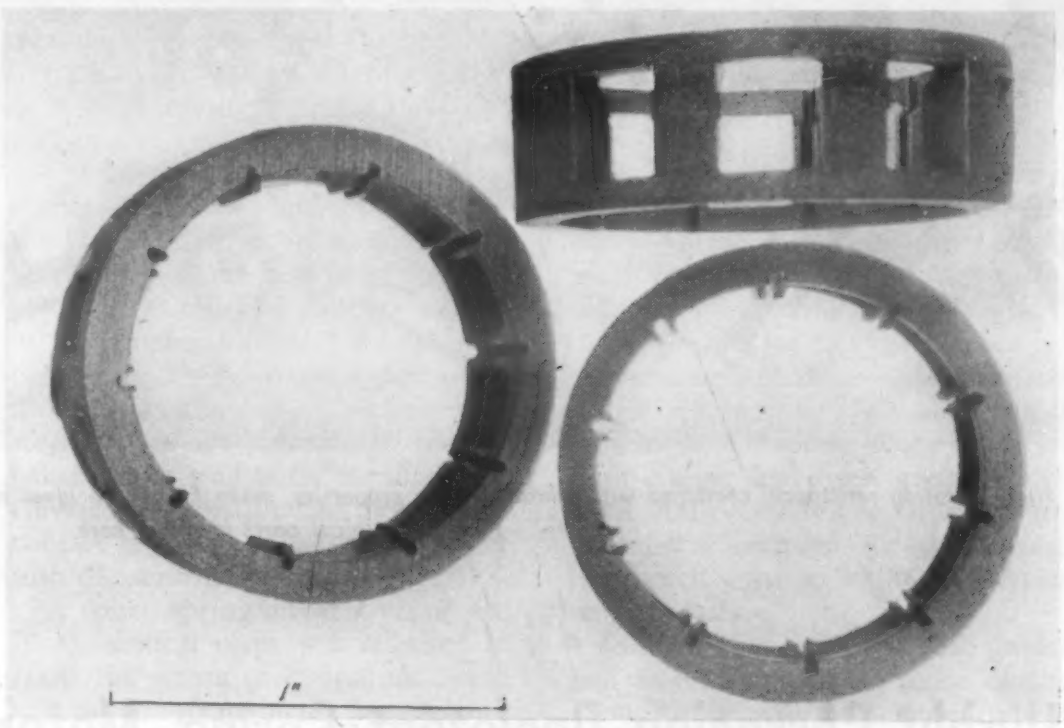
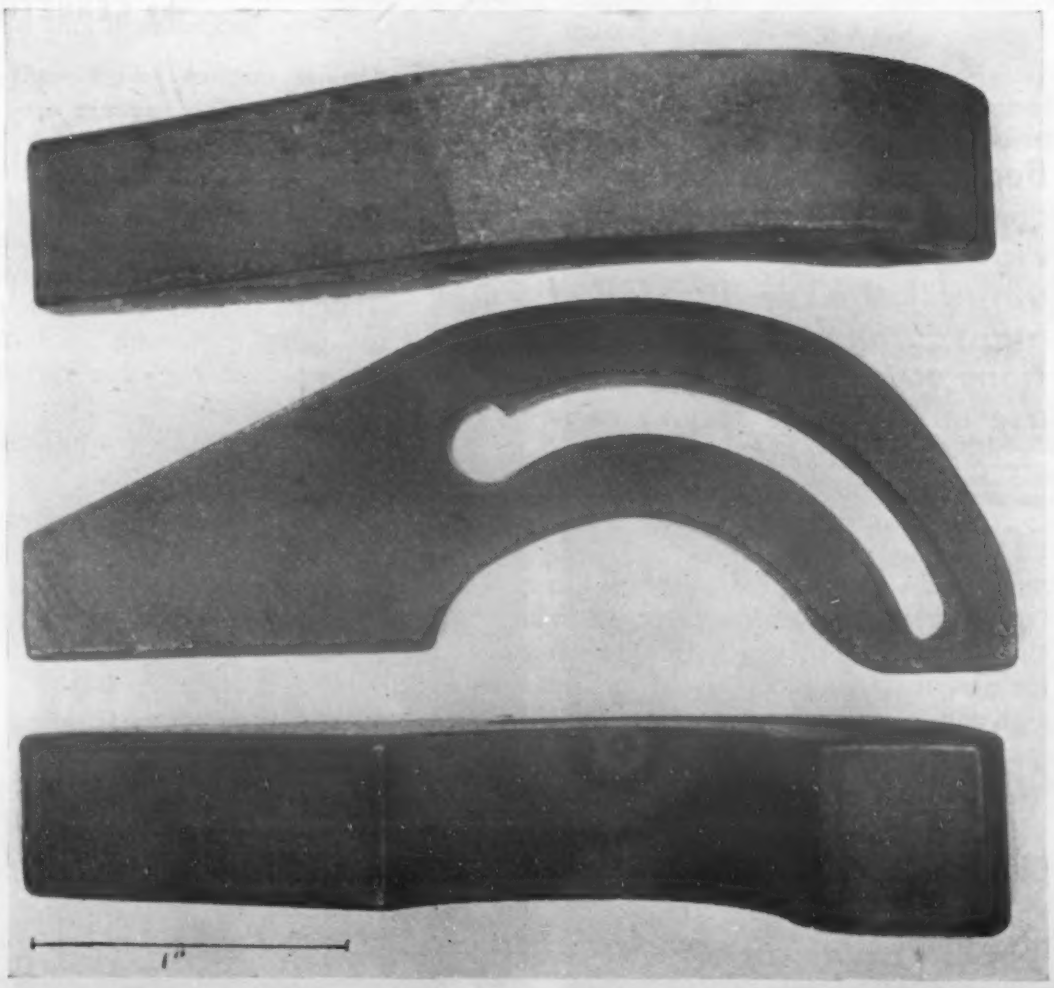
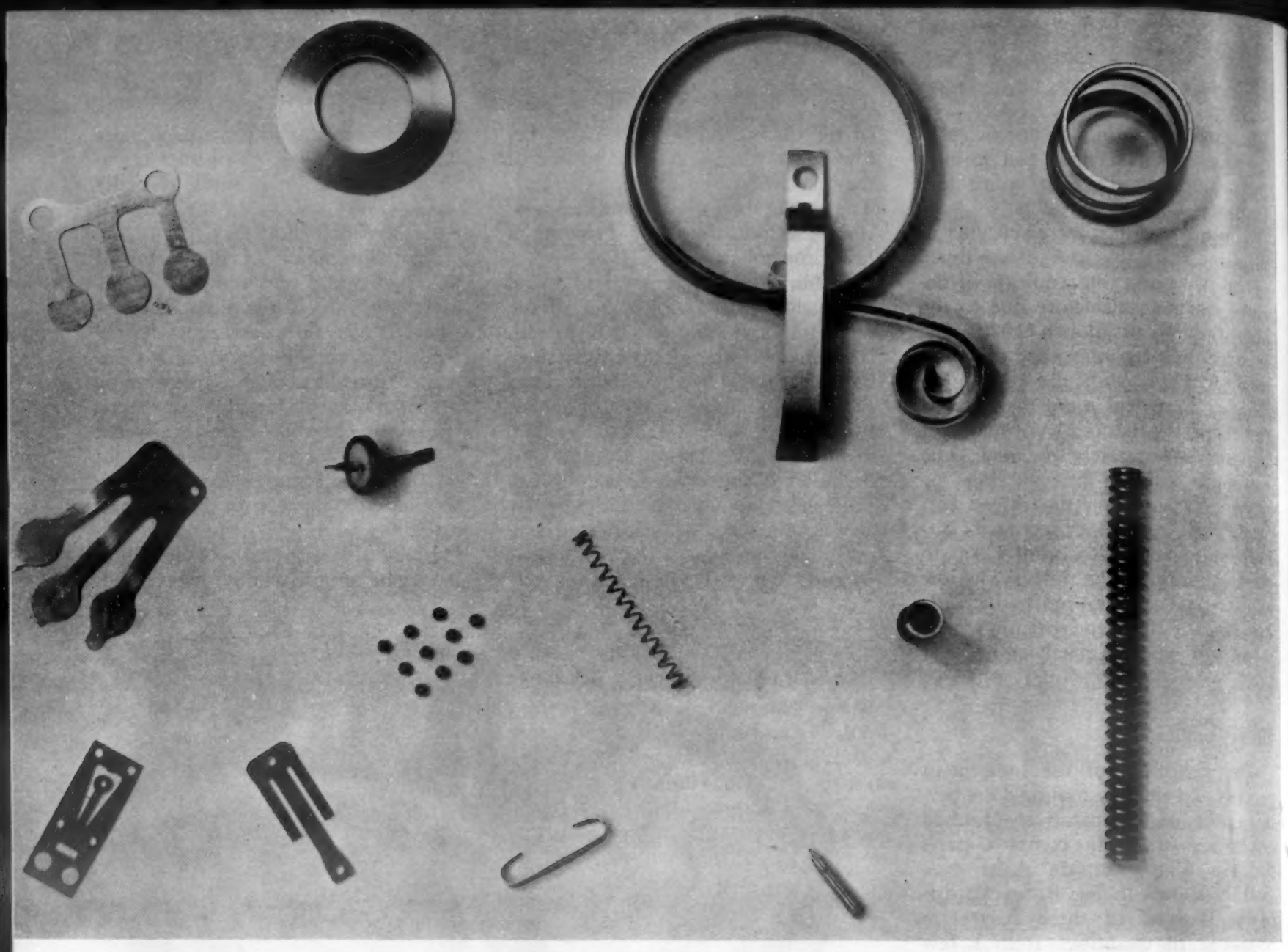


Fig. 8—Roller cage castings.

Fig. 9—Aircraft gas cap locks.





High corrosion resistance, combined with unusual spring properties, make Elgiloy an ideal material for many difficult applications. A group of typical parts is shown here.

Highly Corrosion Resistant Spring Material Finds Varied Use

by **KENNETH ROSE**, Western Editor, Materials & Methods

Because of its exceptional combination of properties, Elgiloy, a cobalt-chromium-nickel alloy, has found many important applications outside of its original use as a watch spring material.

● SEVERAL YEARS AGO the Elgin National Watch Co. announced a new alloy, intended primarily for watch springs, that combined exceptionally high corrosion resistance with unusual spring properties (see MATERIALS & METHODS, April 1947). The cobalt-base alloy was offered under the trade name Elgiloy. Developments of other uses of the alloy by various industries since its announcement have shown that it has many important applications outside of its use as a spring material.

The alloy has the following nominal composition.

Cobalt	40%
Chromium	20%
Nickel	15%
Molybdenum	7%
Manganese	2.0%
Beryllium	0.04%
Carbon	0.15%
Iron	Balance

Properties of the Alloy

Because of the high-cost material in its composition, and the difficulties involved in its preparation and preliminary working, the alloy commands a price of about $15 per pound.

The alloy and its properties were described in MATERIALS & METHODS when it was announced, but some of the more important will be given here.

Tensile strength (heat treated)	368,000 psi.
Yield—0.02% offset (heat treated)	270,000 psi
Hardness (heat treated)	R.58

Specific Gravity 8.3
Thermal expansion
12.7×10^{-6} per deg. C
Electrical resistance
600 ohms per cir. mil ft.

The material can be welded, soldered, or brazed. It can be machined with carbide tools, but tends to work-harden, and so gives difficulty in ordinary machining operations. Mechanical characteristics, and especially spring properties, are retained to a satisfactory degree at sub-zero temperatures, and up to about 750 F.

The alloy is hard, but capable of cold forming; nonmagnetic; heat treatable under controlled conditions; and has corrosion resistance in the heat-treated condition slightly better than in the untreated state.

Cold working hardens the alloy quickly, but even after rolling it can be sheared, coiled, or formed into simple shapes. Heat treatment and work hardening are balanced for each application so as to permit fabricating the alloy to best advantage while insuring that best mechanical properties will be developed in the finished piece. Heat treatment is necessary to development of maximum strength in the material.

Properties of the alloy will insure its use primarily as a corrosion resistant spring material. It is the only corrosion resistant spring material that can be used interchangeably with carbon steel. Its mechanical properties are superior to carbon steel. Both the modulus of elasticity and the modulus of rigidity of Elgiloy are the same as that of carbon steel in spring tempered condition. The alloy possesses exceptionally high set resistance (resistance to permanent deformation) and at least twice the fatigue resistance of competitive spring materials. Corrosion resistance, both to atmospheric corrosion and to chemical attack, is superior to that of the best stainless steels. In addition to all these features, its high resistance to set permits a more constant delivery of torque over extended times.

Applications

In addition to its possibilities as a corrosion resistant spring material, Elgiloy has found a place for itself in industry upon the basis of its exceptional chemical resistance. It is highly resistant to organic acids, is more resistant to hydrochloric acid than the best stainless steels, and about equal to stainless steels in its resistance to nitric acid. It combines exceptional strength with this chemical resistance, and in the heat-treated condition the yield strength may be about 270,000 psi., with an ultimate strength of 370,000 psi.

Elgiloy has replaced a gold alloy in the pen nibs of the Parker 21 fountain pen. This has been the only material yet found other than gold which could withstand the corrosive action of modern inks. Another present application of the material in which it was selected because of its high corrosion resistance and nonmagnetic properties, combined with high physical strength, is in balls for ball bearings intended for scientific and industrial control instruments. Here the high shock resistance of the alloy, combined with the excellent surface finish obtainable, were the determining factors in selection of the material.

Although the alloy was developed as a watchspring material, a large part of the present output goes into industrial devices for which spring properties are required. Flapper valves for small gasoline motors had been made of the best Swedish steel, 0.005 in. thick. The flappers were 3 in. long and 1 in. wide. When made of Elgiloy they gave approximately three times the life of the Swedish steel. Valves are placed over the exhaust side as well as on the intake, so elevated temperature and the effect of contact with the exhaust gases enter into the service conditions.

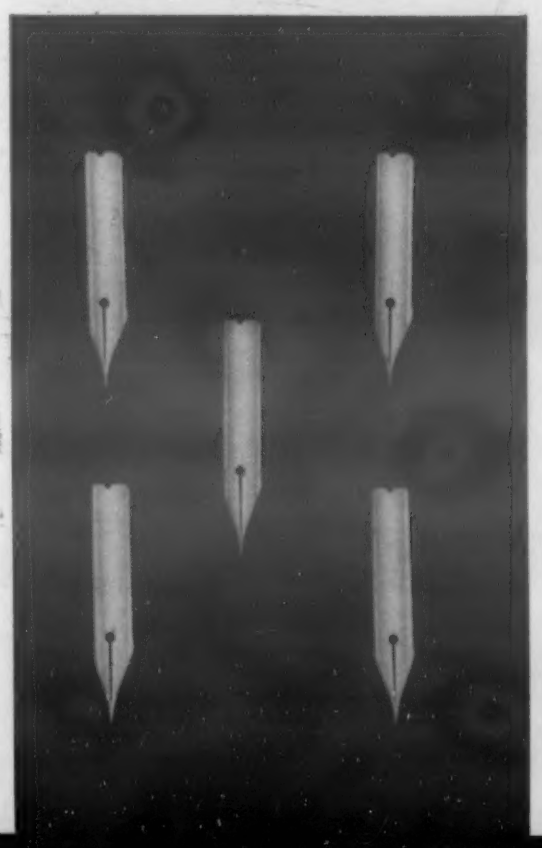
A coiled spring under a vapor seal in a chemical plant was required to resist the action of hydrofluoric acid vapors, and to maintain its mechanical characteristics under constant maximum load. This latter condition demanded high creep resistance. The cobalt alloy gave satisfactory service in this installation.

There are several applications in which springs are not required to have high fatigue resistance, but corrosion resistance and resistance to setting are important. Ammunition components have made use of the corrosion resisting alloy for springs that must operate only once, but must withstand the effects of long storage.

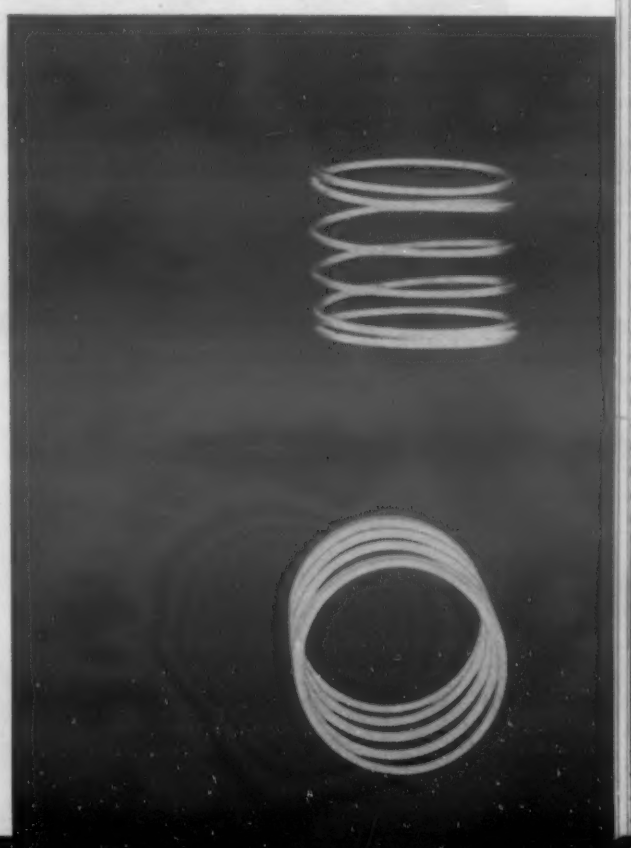
Flat bands made of Elgiloy have been successful in a difficult assignment for which both corrosion resistance and high mechanical properties are required. Industrial weigh scales may be placed in service in corrosive atmospheres, and the alloy, because it resists deterioration under all service conditions yet tried, has won a place for itself in this application. As an example of its success, scales for packinghouses formerly lasted for a period of from one day to six months before the steel draft bands failed. Failures were costly far beyond the value of the part, for it was sometimes necessary to send a service man on a long trip to replace a 15-cent item. At the present time, Elgiloy parts have run for two years without failure.

The high mechanical properties alone have justified the use of the cobalt spring alloy in an electrical unit. A switch spring made of beryllium copper had been giving about 2,000,000 cycles before failure. With the new alloy used for the spring, the switch went to 30,000,000 cycles without failure.

In the textile industry thread guides and traveller rings are made of the alloy. Dental and medical equipment has utilized its high corrosion resistance; wrist watch bands, drawing instruments, camera springs, and sewing machine parts are fabricated from the material.



These Elgiloy fountain pen nibs have as good corrosion resistance as gold and possess much more spring.



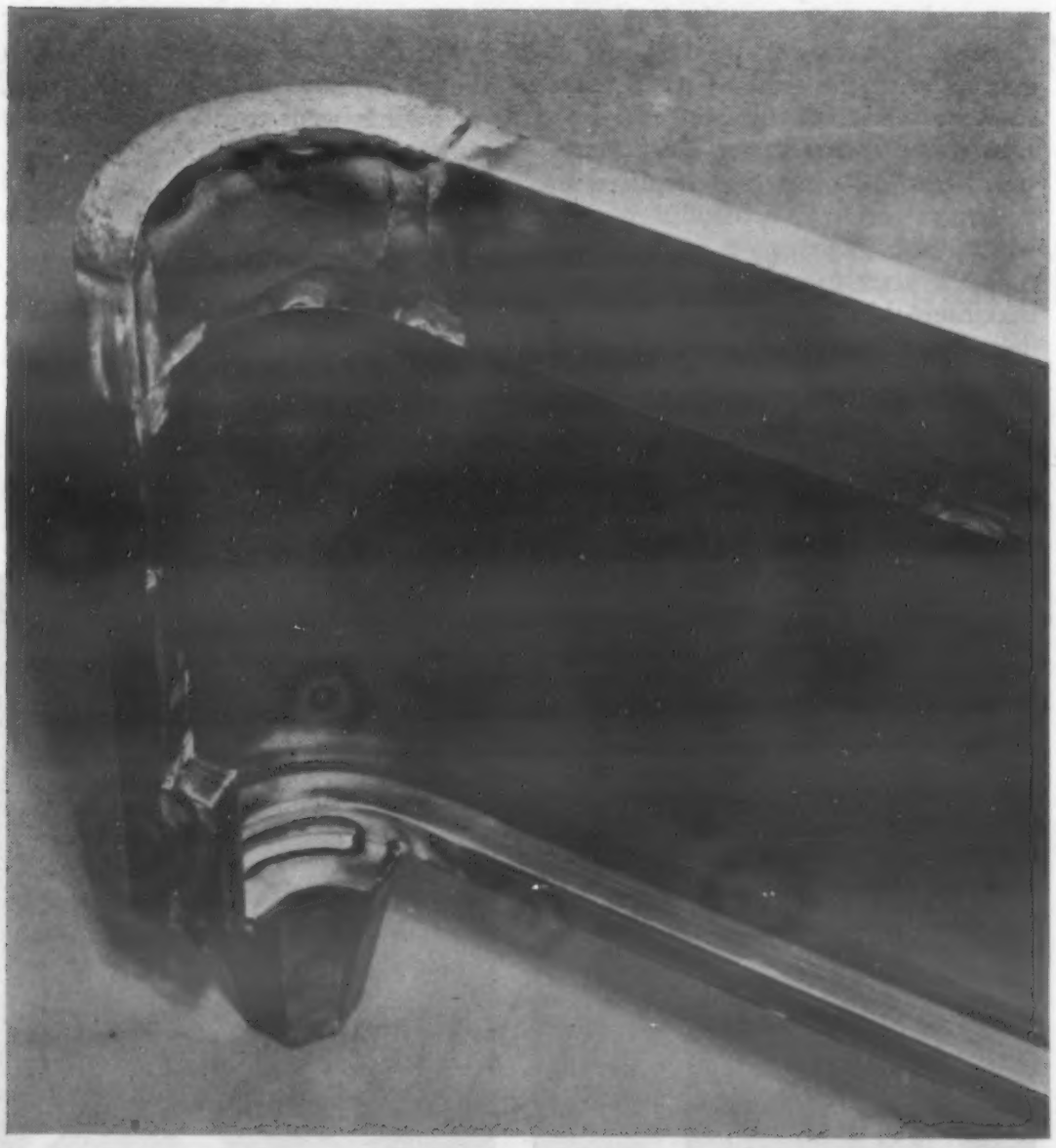
Compression springs such as these, made of Elgiloy, are used in nuclear fission work.

Braze Welding Cuts Costs in Fabrication of Many Products

by C. E. SWIFT, Sales Engineer, American Brass Co.

Sheet metal parts and light wall tube assemblies are readily joined in production using the oxy-acetylene torch and bronze welding rods.

Fig. 1—Bronze is applied over the entire corner insert on this steel bed panel. When finished down, there will be no low spots to be rewelded or filled with solder.



• FOR MANY YEARS the big repair jobs done with the oxy-acetylene torch and bronze welding rods, have attracted our attention because of their unusual size, or the great savings effected by braze welding. But braze welding on production work often presents opportunities for even greater savings that can be repeated week after week.

Most of the production work done by gas welding with bronze falls into one of two groups. One is the joining of formed sheet metal parts ranging in thickness from 0.020 to 0.062 in. Examples are steel dressers and cabinets of all kinds. The other is the joining of light wall steel tube assemblies. Steel tubing is used for chairs, bed frames, special hospital equipment, and many other uses.

To appreciate the full economies of braze welding and brazing, we must look not only at the joining operation itself but at the finished product. What is the cost of the joint including the investment in welding equipment, preparation and fit-up of the metal, welding time and clean-up time?

For gas-welding, only oxygen and acetylene regulators, welding hose, and a torch and tips are necessary. Most production braze welding is done with a flame-fluxing device. With this included, the cost of equipment is around $250 per operator.

Exact fit-up of joints is not necessary. Gaps between lapped sheets, or butted edges of sheets or tubing, can readily be filled. The low fuming bronze generally used shows a weld strength on steel of 55,000 to 65,000 psi. This is ample for most steel. Weld deposits are sound. And this is vital where many joints are ground flush with the steel.

Usually the biggest saving in braze welding and brazing is in that little or no finishing is required after the joint is made. Fillets are smooth and corner welds or butt joints sand down to smooth metal in a few seconds. Flame-fluxing leaves no heavy beads of borax glass to be removed. There is no flash or weld spatter to worry about. And the low temperatures required for braze-welding minimize distortion.

Small assemblies are held in fixtures that can be rotated in one or two planes. The welder can turn the work quickly to the best position for making each joint. On larger pieces, it is not difficult to braze-weld on vertical or even overhead surfaces. The torch is light and easily moved from joint to joint in any assembly.

The bronze is applied with rela-

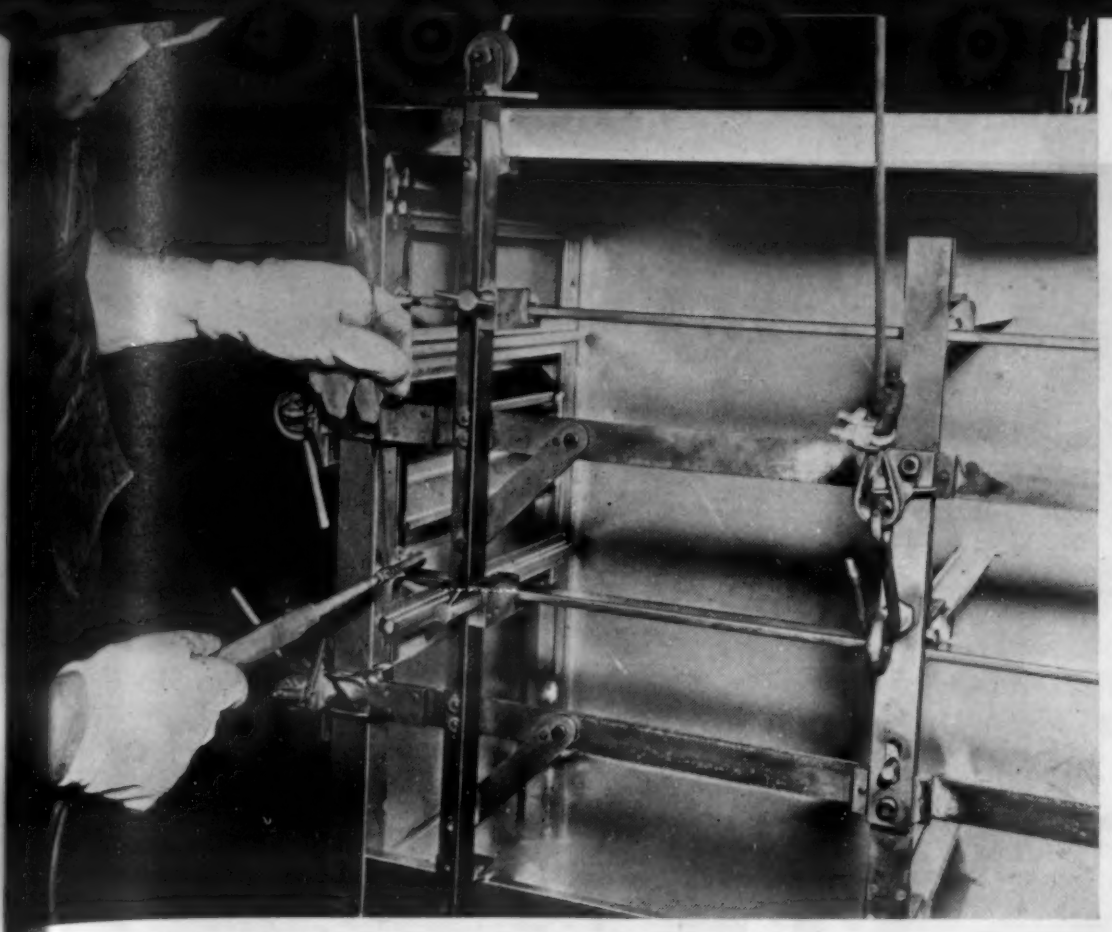


Fig. 2—A welder applies low fuming bronze to a cross rod held in place in a steel dresser by an ingenious fixture.

tively large welding tips in the torch. Large tips are used to make the joint quickly with the least possible total heat input. This greatly reduces, and in many instances eliminates, distortion. Flame-fluxing is helpful in this respect, too. The right amount of flux is on the work and the rod just where it is needed.

Typical of braze-welding applications on sheet steel are those shown in accompanying figures. Fig. 1 shows a steel bed panel which has many types of joints between metals of various thicknesses. On the top corner the steel insert was completely covered with bronze. It is faster to flood the bronze across the whole insert than to make two corner welds. Also, the wide bronze deposit compensates for any irregularities in fit-up and the joint cleans up with one grinding operation.

In Fig. 2, a welder is braze-welding runners, cross-rods and side supports in a steel dresser. Note the simple lap and butt joints that can be used when this method of welding is employed. Sections can be formed without thought of having to get inside them later with a resistance welding electrode for spot welding. There is no danger of burning through with metallic arc welds, and there is no flash or spatter to interfere with the smooth operation of drawers.

Steel tubing is being used more and more for structural purposes. Fig. 3 shows a lounge chair made of tubing and fabricated by braze welding. The fillets made with bronze are smoothly concave and require no finishing. The joints present a neat, streamlined appearance in the as-welded condition. Note the many types of intersections that are easily braze-welded, and the butt joint, ground smooth, in the center of the frame. There are lap joints between full sections of the square tubing and intersections between large and small sizes of tubing. All joints are quickly made in one fixture or by turning the chair after it is out of the jig.

Fig. 4 is a good example of the type

Fig. 3—View of a completely brazed chair. The design is simple, making full use of the adaptability of braze welding to many types of joints.

Fig. 4—This fixture holds all parts for a piece of outdoor furniture in accurate alignment without interfering with the braze welding.

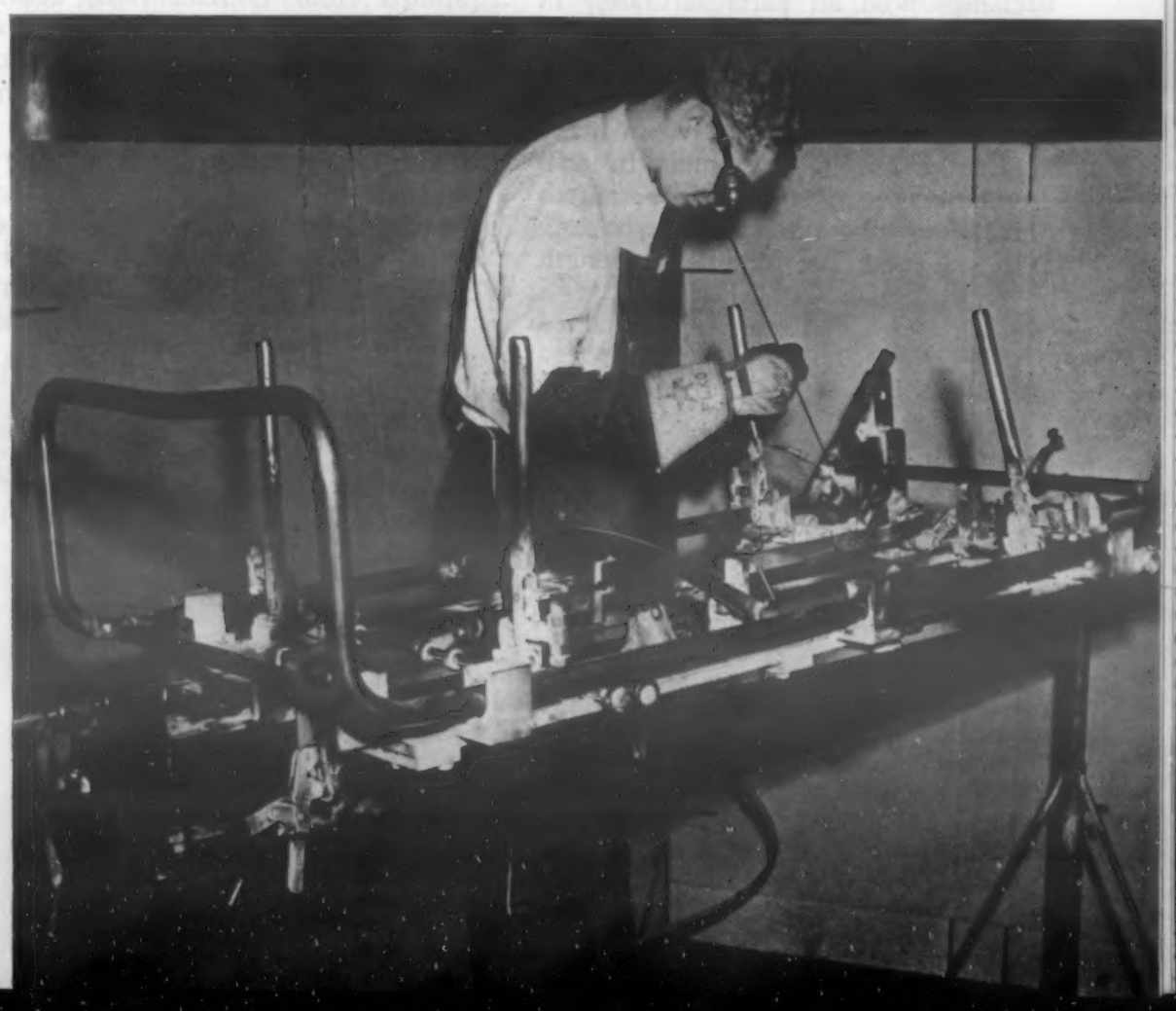


Fig. 5—The welder applies high strength nickel silver brazing alloy to intersecting steel rods. He makes a smooth joint, ready to paint.

of fixture used for assembling tubular steel outdoor furniture. Quick acting clamps hold all parts accurately in position. The whole fixture is mounted on trunnions so it can be rotated 360 deg.

Solid steel rods are used in many places on hospital equipment. In some instances the highest possible strength is required, so a nickel silver brazing alloy is used. The weldmetal strength will run 60,000 to 70,000 psi., with much higher strengths developed where the brazing alloy runs in between butted or lapped surfaces. The nickel silver alloys are applied with the same torches and flame-fluxing devices used with the low fuming bronzes. Fig. 5 shows a part for a hospital bed made from round rods.

With braze-welding, it is possible to join dissimilar metals with practically no more fuss than with low carbon steel. Fig. 6 shows an angle rerolled from railroad rails, being joined to a bronze casting. It is a part for a hospital bedside cabinet. Note the smooth fillet in the corner between the steel and the bronze.

The use of bronze with the oxy-acetylene torch has not been pushed out of the production welding picture by the various forms of electric welding. It stills has a definite place. Improvements in torches, regulators, bronze welding rods and fluxes and fluxing devices have kept pace with other advances in industry. Wherever sheet metal or light wall tubing is to be fabricated look for possible savings in production by gas welding with bronze. Savings usually average 40 to 60%. Such economies are well worth looking for.

Fig. 6—This brazed joint on a piece of hospital equipment is well proportioned, smooth, and will readily take a good paint job.

This article is based on a paper presented at the International Acetylene Assn., Mar. 27-29, 1950.

New Synthetic Fiber Has Many Characteristics of Interest to Industry

Among the many favorable properties claimed for Orlon acrylic fiber are excellent resistance to sunlight, weathering and water.

—A NEW MATERIALS PREVIEW

• THE E. I. DU PONT de NEMOURS & CO., INC., which developed and introduced nylon, has announced another synthetic fiber that promises to be of considerable interest to industry. The newest is called Orlon, and it is intended to supplement the present synthetic textiles in both the consumer and the industrial markets. It also offers at least a possibility of developing into a material for the plastics molding field, though it is too early to estimate its potentialities in that direction. It is likely to appear as a film-making material before its molding possibilities are explored.

The new plastics fiber is a polyacrylonitrile, and as such is of the same chemical family as the acrylonitrile synthetic rubbers. Control of properties is effected first of all by controlling the molecular weight, or length of chain, during polymerization. Acrylonitrile polymers of lower molecular weights possess the flexibility and stretchability found in the synthetic rubbers, known during the war as the "Buna N" synthetic rubbers. The molecular weight of the material for textile fibers is sufficiently higher to give the synthetic a greater degree of rigidity.

Some of the characteristics of the fiber of interest to industry are:

1. Resistance to outdoor exposure. In exposure tests at Wilmington, Del., Orlon retained 77% of its strength at the end of one and one-half years, when nylon, several rayons, and linen and cotton had failed completely. It is, according to duPont's chemists, the best fiber now known for resistance to weathering.

2. Chemical resistance. Its resistance to mineral acids is good, it withstands the common solvents, and oils and greases. Its alkali resistance is considerably poorer than that of nylon, though it possesses fair resistance to weak alkalies.

3. Resistance to bacterial attack. It possesses excellent resistance to the action of bacteria causing rotting, and in addition it resists such insect enemies as clothes moths, cockroaches, and carpet beetles.

4. Strength at elevated temperature. The new fiber possesses good strength at elevated temperatures, and should be suitable for use at temperatures somewhat above the boiling point of water.

5. Electrical properties. Orlon possesses good dielectric properties, especially at microwave frequencies.

6. Flammability. The material is combustible, but does not flash into flame.

7. Water resistance. It absorbs only 2.5% water, as compared with 8% for nylon and 60% for acetates.

Compared with nylon, the polyacrylonitrile fiber has poorer abrasion resistance, better water resistance, poorer alkali resistance, and retains slightly less of its strength when exposed to elevated temperatures in air. It has better flex life than nylon. It has been heralded as the most silklike of the synthetic fibers when produced as a continuous filament, and as the most woollike when produced as stable fiber.

Some of the possible industrial applications for the continuous filament are in awnings, tarpaulins, automobile tops, filter fabrics, electrical insulation, mine belting, anode bags, tents, and sewing thread for outdoor use. It is also expected to go into sports clothing for men and women, curtain fabrics, rainwear, and blankets.

Orlon acrylic fiber is excellent for wet or dry filtration. It has good to excellent resistance to mineral acids, fair to good resistance to weak alkalies, and excellent resistance to common solvents, oils, greases, neutral salts, and some acid salts.

Cut-away section of filter fabric made of Orlon acrylic fiber.

Finishes Successfully Baked on Nonferrous Products by Induction Heating

by **FRANK NETSCHERT**, Chief Engineer, Technical Glass Co., Inc.

Induction heating can provide the means for quick and effective baking of organic finishes on many metallic products.

● INDUCTION HEATING has joined gas oven and infra-red baking as a means of rapidly and effectively drying protective finishes. It is being used successfully today by the Technical Glass Co. of Los Angeles for baking and curing synthetic enamel finishes on aluminum and brass builders' hardware products. In fact, since its installation in May, 1947, the company's 15 KW, 10,000 cycle Tocco induction heating unit has eliminated many of the troubles that plagued earlier baking processes in addition to effecting several decided economies.

Some of its distinct advantages are:

1. High, uniform product quality.
2. Adaptability to varied uses.
3. Ideal shop working conditions.
4. Low maintenance and operating costs.

It is in quality of product, especially, that induction heating has proven superior. Both the gas and infra-red processes bake the outside of the enamel more thoroughly than the inside, no matter what the thickness of the enamel layer may be. This non-uniform baking results in a lowered resistance of the finish to attack from outside sources. Furthermore, any gas trapped in the liquid enamel is sealed in during gas or infra-red baking, causing blisters and soft spots in the coating. The sealing effect results from the outside of the enamel being baked not only first, but more quickly than the inside.

In induction heating, however, voltages are generated in the metallic object itself. The resulting current flow quickly heats the metal to any desired temperature and bakes the enamel in contact with the metal surface first. As the enamel hardens from the inside out, the gases are expelled.

Another important requirement in the proper baking and curing of synthetic enamel is that the correct temperature be reached and held for a certain length of time. Both gas and infra-red baking sometimes fail in this respect, the temperature in the baking oven varying considerably. Here again induction heating is superior, allowing a constant temperature to be maintained throughout the baking.

Of course, the ultimate test of a process is the quality of the finished product. Salt spray tests conducted by an independent testing laboratory on the brass plated products of the Technical Glass Co., which uses a standard enamel for its finishes. were discontinued after 300 hr. with "no change" reported. Under the same conditions (a 20% salt spray at 90 F and 100% relative humidity) 11 other brands all failed between 24 and 168 hr. after spraying began. And, as final proof of the effectiveness of induction heating in product quality, the company offers, with every plated aluminum object it manufactures, a guarantee that the finish will last the consumer ten years under normal conditions.

Quality of product, of course, is not the only consideration a manufacturer must take into account in deciding upon a new process. Adaptability to mass production techniques and to frequent changes of jobs can mean the saving of labor, floor space and hours of production time. Both gas oven and infra-red baking have some disadvantages in this respect.

Infra-red heating requires large batteries of lights and long, insulated tunnels in order to reach baking and curing temperatures necessary for synthetic enamel. If the infra-red process were substituted for the induction heating method to bake the same number and kinds of parts now processed at the Technical Glass Co., three or four times as much floor space would be required. While gas ovens do not require excessive floor space, it is difficult to adapt them to the conveyor-type production used by the company because oven doors must be kept closed to maintain a constant temperature. For this reason, baking can be done only intermittently, a loading at a time. A further complication in gas baking is the fact that, during loading and unloading of the oven, considerable heat escapes, requiring time between each operation to restore proper temperatures.

In the induction-heating process used by the Technical Glass Co., 288 work-holders are spaced 2¼ in. apart on a 55 ft. continuous chain. During a production run, enamel is applied by automatic spray guns, whose action is controlled by the speed of the chain. As the conveyor moves out of the enamel spray, it enters a filter air tunnel which keeps the work free from contamination and allows adequate "flow out" time for the removal of excess solvents. The conveyor then passes through the baking chamber containing a channel-type induction coil which is energized by the Tocco power unit. Since the work is not handled between the spraying and baking processes, loss of production through contamination from dust and dirt or from marking and smudging is eliminated. Between the baking chamber and the unloading station, the work moves through insulated tunnels for the prolongation of the curing process.

Changes in production jobs can be accomplished with a minimum loss of time by changing the work-

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This article is based on Mr. Netschert's honorable mention-winning entry in the Tocco "Economy in Production" contest.

holders while the conveyor is moving. Occasionally, for work of different sizes, it is also necessary to change to a larger or smaller channel-type induction coil. In addition, baking temperatures are attained in a matter of seconds by induction heating, while both gas and infra-red heating require several minutes. Usual production runs require only one unskilled operator, who loads and unloads the work. Occasionally, on extremely fast runs, two are needed.

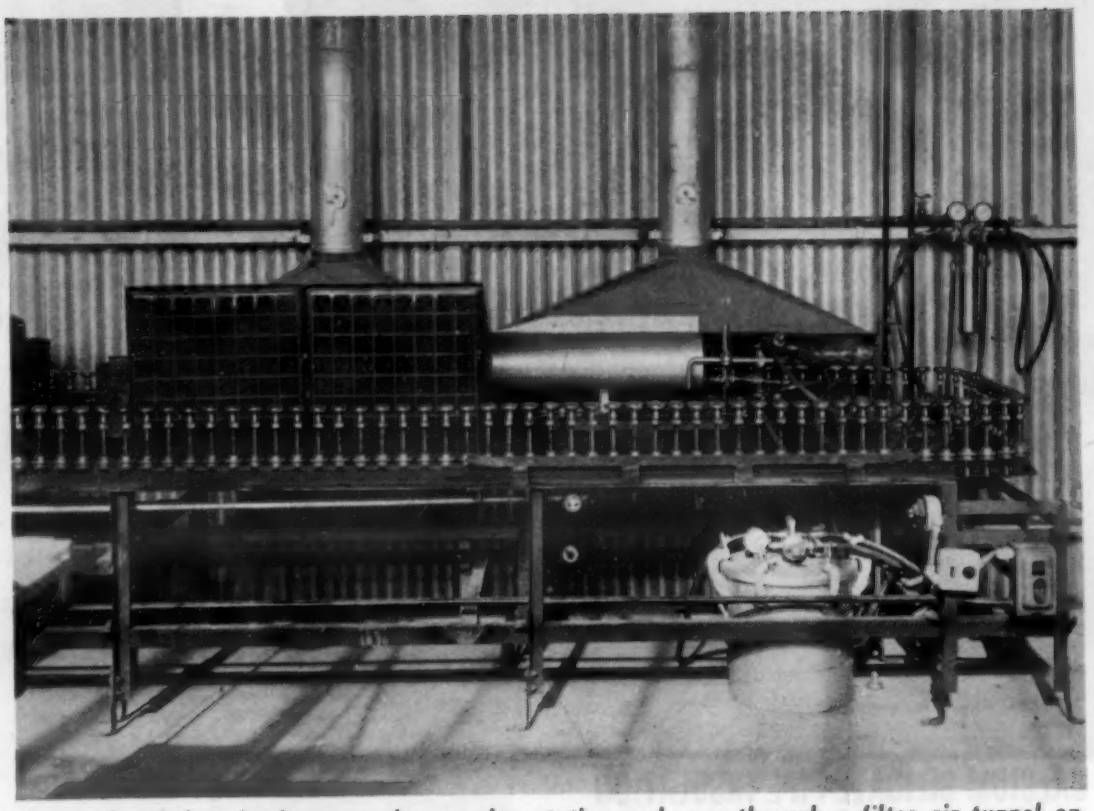
Two important factors sometimes overlooked by the manufacturer in weighing the advantages provided by different processes are the safety and comfort of his employees. Here again, the induction heating baking process has proved superior in the Technical Glass Company's production.

The glare and heat radiating from a large bank of lamps often creates a personnel problem as does the heat from gas ovens, which sometimes raise surrounding temperatures to uncomfortable levels. In addition, the problem of fumes escaping from gas ovens must always be considered. Furthermore, because the thinner used with synthetic enamel is highly combustible, gas ovens and, to a lesser extent, infra-red lamps provide a possible fire hazard.

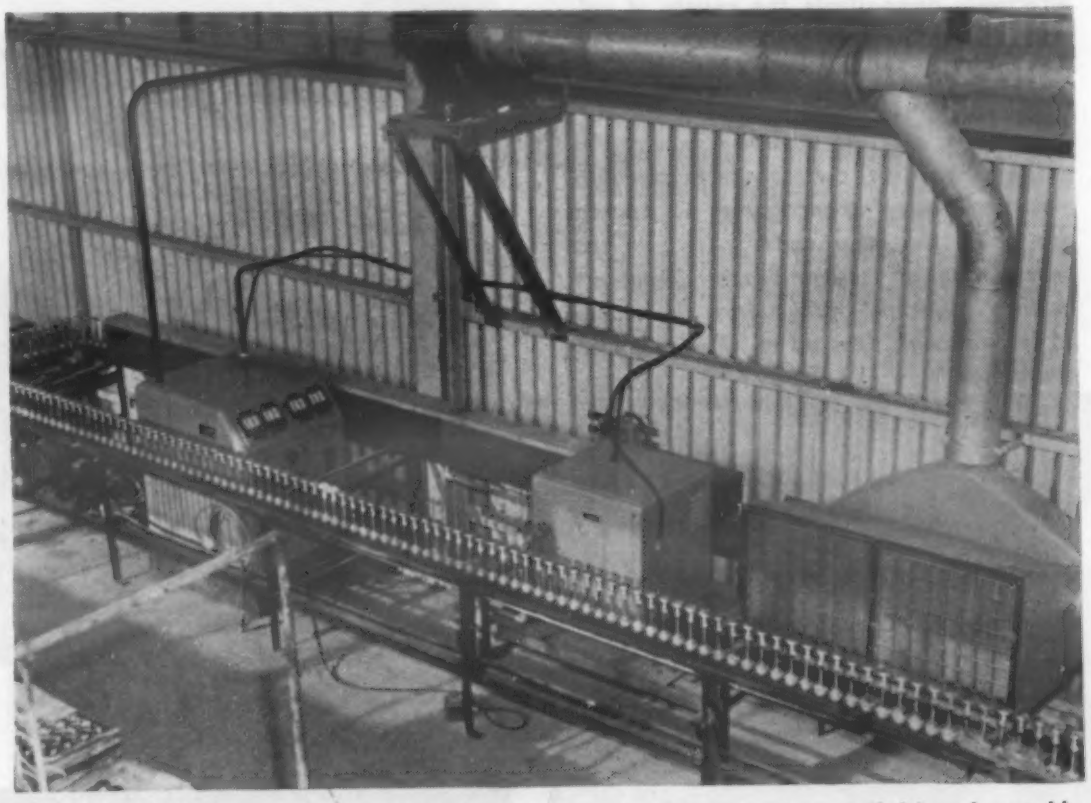
Induction heating, on the other hand, offers a minimum of heat, no glare or fire hazard and, in general, the safest working conditions possible in this type of operation.

Of course, the economical aspects of induction heating are self-evident from its adaptability to mass production techniques, time saving operations, and the minimum of space, labor and number of rejects all mentioned earlier in this article. The economy of this process is emphasized further by the accompanying table prepared by the Technical Glass Co. Also, it is estimated, that to provide the same heat supplied by induction heating in this application, it would be necessary to use between 120 and 150 infra-red lamps which would require almost four times as much power.

While the experience of the Technical Glass Co. in the use of induction heating has been confined solely to baking enamel on builders' hardware products, there is no reason to believe that similar processes cannot be applied to other products in other industries. Certainly, the outstanding success that has marked its use so far warrants industry's serious consideration of induction heating for baking protective finishes.



Brass plated door knobs enter the spraying station and pass through a filter air tunnel on their way to the induction chamber at the extreme left.



A minimum of floor space is occupied by the Tocco motor generator set (left) and portable power unit (right). The long, insulated tunnel retains heat long enough to cure the enamel properly.

Economy with Induction Heating

Item	Material	Weight of Each Article	Rate of Production	No. of Operators	Labor Cost
Roses or Escutcheons	Brass, 2 in. dia.	½ oz.	6500 per hr.	2	$0.00034 each
Door Knobs	Aluminum, brass plated, 2 in. dia.	3¾ oz.	1000 per hr.	1	$0.0011 each
Cylinder Door Knobs	Aluminum, brass plated, 2¼ in. dia.	3½ oz.	450 per hr.*	1	$0.0024 each

** The reason for the slower production rate on this item is due to the fact that alternate work-holders are used. The diameter of the article being the same as the spacing of the work-holders does not allow every holder to be used as the articles would be rubbing against each other.*

Materials at Work

Here is materials engineering in action . . .
New materials in their intended uses . . .
Older, basic materials in new applications . . .

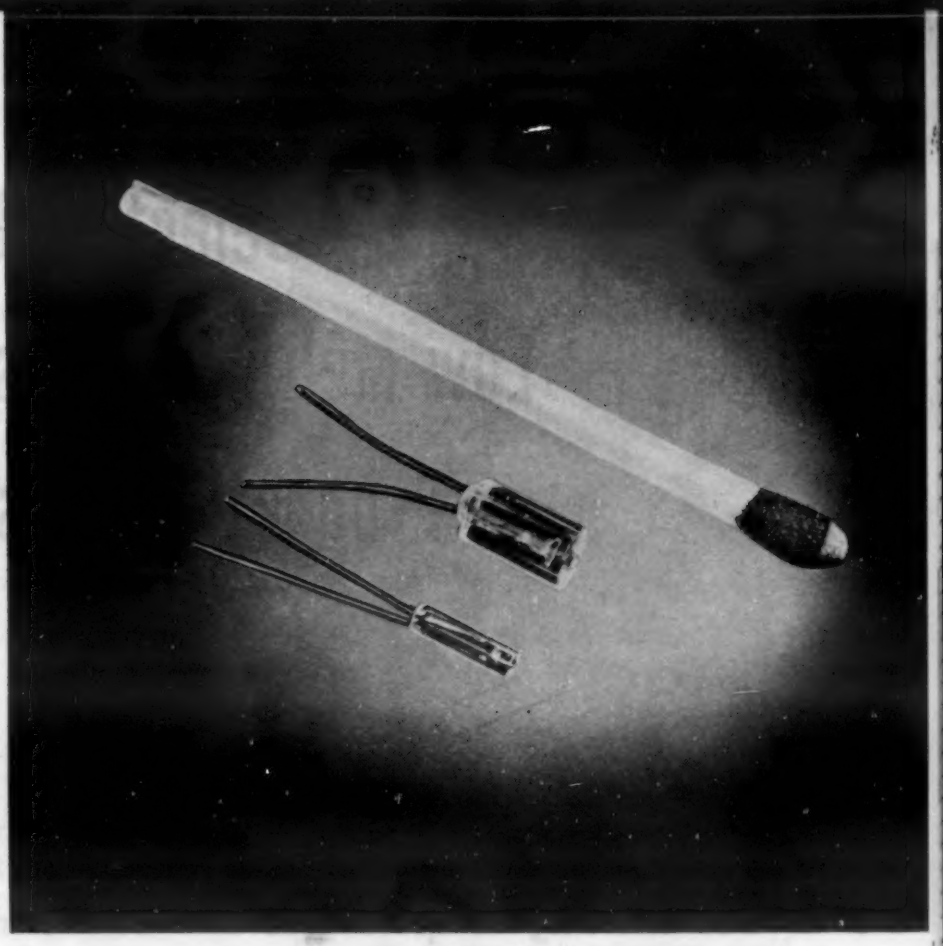
CALCIUM-SILICATE PIPE INSULATION

Although this "telescope" is more of a detriment than an aid to vision, it does effectively demonstrate the variety of calcium-silicate pipe insulation sizes manufactured by the Kaylo Div. of the Owens-Illinois Glass Co. An unusual feature of the pipe covering is that its outside diameter, as well as the inside, corresponds to standard pipe sizes—allowing sections to be stacked one inside the other and resulting in the conservation of storage space. Diameters in the "telescope" range from ¾ in. to 36 in., although sizes up to 72 in. are also available.

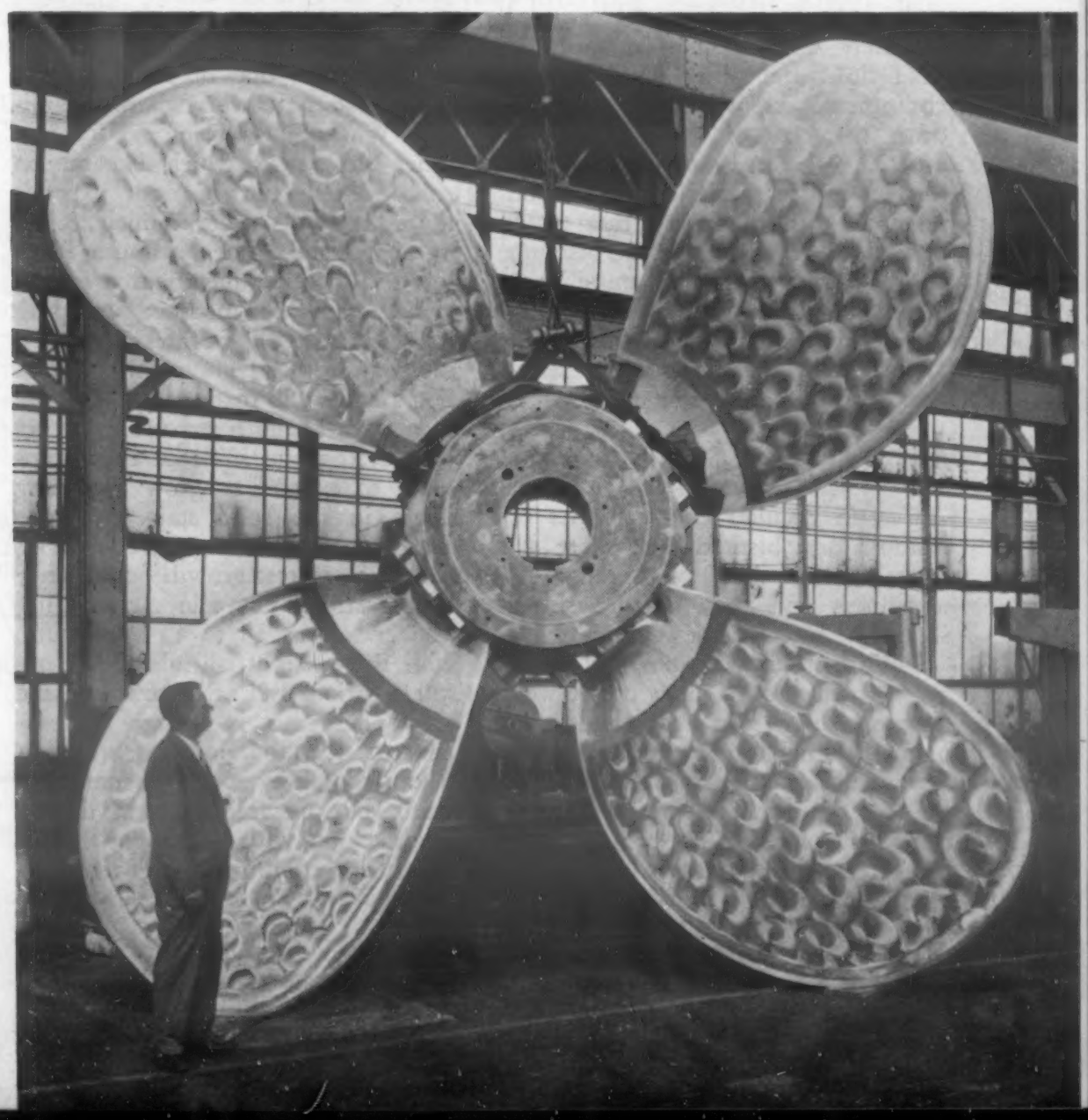
"FORGED DOUGHNUT"

What is probably the world's largest (and most indigestible) "doughnut" is shown here immediately after being taken from a furnace in the Kropp Forge Co.'s Chicago plant. A vivid example of what the modern blacksmith, equipped with mechanized hammers weighing 20,000 lb. and more, can produce, the "doughnut" represents the first stage in the production of a mammoth ring gear.

RUBBER STREETCAR FENDERS *These workmen, mounting Neoprene rubber fenders over the wheels of streetcar trucks, are solving what used to be a troublesome problem for the Detroit Street Railway Dept. Metal fenders, formerly used on Detroit streetcars to protect electrical equipment from mud, oil, water and grease, required frequent servicing, broke at mounting brackets, were attacked by rust, and had to be replaced at the rate of four a day. Twelve-month tests with rubber fenders, however, showed that they required no servicing or replacing, resisted corrosion, and provided quieter operation. Developed by the U. S. Rubber Co., the fenders will save the city an estimated $10,000 annually.*



MINIATURE PHOTOELECTRIC CELL *An ordinary matchstick dwarfs these germanium-type photoelectric cells recently developed in the Sylvania Electric Products, Inc. laboratories. Relatively small changes in light intensity produce enough current in the cells to operate an electric relay without electronic amplification, pointing to their future use in such applications as decoding punched tape and electronic computing and sorting. The experimental models shown here consist of a tiny piece of germanium in contact with a fine wire or "whisker" sealed in a solid piece of plastic. In addition to serving as a rugged, sealed housing, the plastic provides an effective light path to the point at which the whisker makes contact with the germanium.*



GIANT SHIP PROPELLER *The largest ship propeller ever built in the United States is pictured here after completion by the Baldwin Locomotive Works. Designed for a large tanker now under construction, the propeller is 22 ft. in dia. and weighs 71,500 lb. The four separate manganese bronze propeller blades are bolted to the cast iron central hub. Light reflections from the distinctive pattern made by the polishing tool cause the odd, mottled appearance of the blades.*

How to Select and Use Low-Melting Alloys as Production Aids

by O. J. SEEDS, Cerro de Pasco Copper Corp.

Low melting temperatures and controllable shrinkage characteristics make these bismuth alloys valuable tools in many fields of industry.

• DURING THE PAST 20 years, bismuth has become an important industrial material through the development of its alloys. Prior to this period the chief uses for bismuth were in the production of pharmaceutical salts and in the low melting solders used in safety devices such as sprinkler head links and other fire detection equipment. As was true of many other materials of little known industrial value, pressure of wartime activity spurred experimentation and research with the result that many new uses were found for the bismuth alloys. Today there are more than 70 known useful ways of employing them. It is the purpose of this article to discuss briefly the uses and selection of these low melting alloys.

Properties of Bismuth Alloys

Certain peculiar characteristics of bismuth and bismuth alloys are responsible for their wide range of usefulness and these characteristics should be briefly reviewed.

Published compositions and melting temperatures of many of the well known bismuth alloys found in some of the handbooks and other literature do not agree. This is chiefly due to the fact that metals available were not always of the highest purity and measurement apparatus was not too accurate. Therefore, the data in Tables 1 and 2 have been compiled from determinations more recently and accurately made for several of the better known bismuth alloys in commercial use. Each of the alloys in the tables has been assigned a reference number to serve as identification throughout this article.

Bismuth is one of few elements which does not shrink when it solidifies. Water and antimony are two other substances which expand on solidification, but bismuth expands more than the former; namely, 3.3% of its volume. When bismuth is alloyed with other metals, this expansion is somewhat modified according to the relative percentages of bismuth and other components present. For example, in many alloys of more than 48% bismuth, expansion occurs on freezing and some of them continue to expand or grow for many hours in the solid state. In some alloys of the above type, containing lead, the greatest growth occurs after solidification. Some alloys, containing lead and from 35 to 45% bismuth, will show slight shrinkage during solidification, and aftergrowth in the solid phase that is enough to compensate for the initial shrinkage. Alloys containing 50% or more bismuth, but no lead, expand during solidification, with only slight shrinkage during cooling to room temperature.

Most molten metals when solidified in molds, shrink or pull away from the mold and thus do not reproduce fine mold detail. Because the high bismuth alloys expand and push into mold detail when they solidify, they are excellent materials for duplication and reproduction processes. These characteristics, in addition to low melting temperatures, have resulted in a great many applications. A few of their specific uses, grouped under major fields of application, are described below in order to illustrate both the range of possible applications and the principles of alloy selection.

Anchoring

Growth or expansion of some of the bismuth-base alloys is largely responsible for their matrix or "anchoring" quality. This growth, which in some of them continues for several hundred hours after solidification, enables them to grip keyed, notched or bossed surfaces on which they are cast, or to tightly fill annular spaces, despite the absence of fusion or bond with the materials with which they come in contact. The following cases are typical of a long list of well-established "anchoring" applications.

Anchoring Bearings, Bushings, Stationary Parts in Machinery, etc.— Oversized holes to receive bearings, bushings, rods or tubes are provided and sleeve bearings are accurately aligned in holes by placing them on their shafts or on same-size bars held in a precisely constructed fixture. Babbitting clay dams are formed and a "matrix" alloy poured to fill the annular space. If stationary rods or tubes are to be anchored by this method, the ends which are gripped in the matrix must be notched, keyed or knurled to prevent movement in any direction.

Large-size bearings, requiring extremely accurate location with respect to their shafts, call for a matrix of low pouring temperature, immediate expansion and minimum aftergrowth. Alloy 13 (see Table 1) was developed for such applications. For smaller bearings and for anchoring rods and tubular members, as in X-ray equipment, Alloy 15 (Cerromatrix) is generally the choice. Alloy 5, or a similar composition, is ideal in replacing worn parts where low pouring temperatures must be used so that finishes will not be damaged.

This method of locating bearings and parts eliminates all costly machining to press fit parts, makes pos-

sible easy field servicing and safeguards against overheating through failure of oil supply, since the inexpensive matrix alloy melts before the bearing is damaged.

Punches and Dies for Blanking, Piercing and Trimming — Punches are located in the die, shimmed if necessary, and the backs of the punches drilled and tapped for cap screws. The punch-holding plate, with oversized tapered holes, small dimension toward die, is lowered over the punches onto parallels resting on the die plate. An auxiliary plate, with slightly oversize holes corresponding to the centers of holes in the punches, rests on the punch plate. Cap screws are inserted and drawn up tight, the parallel clamps holding the auxiliary plate to the punch plate. The assembly is then pre-heated and matrix alloy poured into the spaces surrounding the punches. The anchored assembly should be aged 15 hr. before placing in service.

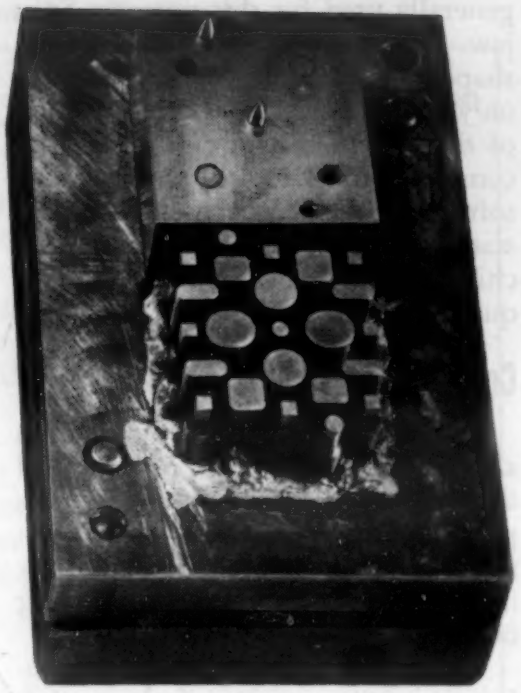
For this type of anchoring service the matrix must be hard, of high compressive and tensile strength, resistant to shock loads and have low pouring temperature with rapid growth and expansion. Alloy 15, developed especially for this application, meets all the above requirements.

This method of die construction is recommended primarily for anchoring irregular shaped punches, sectional dies and complicated dies. It is in these types of dies that the greatest savings occur by reduction or elimination of machining and accurate fitting of non-working surfaces. Reduction in construction time of 50 to 60% is common experience and alterations and repairs are simplified.

Chucks

Closely related to anchoring is the chucking or holding of parts during machining, grinding and testing operations. Suitable retaining dams or mold forms are made to contain the molten alloy to be poured around the part and, in some cases, to provide rests or attachments for clamping to machine tools. This field of use is broad, but a representative example will illustrate the principle.

For split jaw chucks, a wood separator strip is fashioned roughly by hand to conform to the outline of the part. A leak-proof fit of the separator is obtained by bedding it to the part with putty or clay. Two retaining shells of brass or other suitable material are clamped to the separator strip with the part in place, and a low-melting alloy is cast in both halves.



All punches in this die are secured in Alloy 15. Older method of construction would require three-stage die. (Courtesy Lamicoid Fabricators, Inc.)

An alloy which has high hardness for wearing qualities and expands to give a snug fit must be used in this type of application. Alloy 15 is most

Table 1—Compositions and Melting Temperatures of Some Low-Melting Bismuth Alloys

Ref. No.	Composition, %					Melting[1] Temp., F	Yield[2] Temp., F	Trade Name[5]
	Bismuth	Lead	Tin	Cadmium	Other			
1	44.70	22.60	8.30	5.30	19.10 In	117		Cerrolow-117
2	49.00	18.00	12.00	—	21.00 In	136		Cerrolow-136
3	50.00	26.70	13.30	10.00	—	158		Cerrobend
4	50.50	27.80	12.40	9.30	—	158-163	159	
5	50.00	34.50	9.30	6.20	—	158-174	162	
6	42.50	37.70	11.30	8.50	—	158-194	163	Cerrosafe
7	50.72	30.91	14.97	3.40	—	158-183	163	
8	35.10	36.40	19.06	9.44	—	158-214	167	
9	51.60	40.20	—	8.20	—	197		
10	52.50	32.00	15.50	—	—	203		
11	56.00	22.00	22.00	—	—	203-219	205	
12	67.00	16.00	17.00	—	—	203-300		
13	33.33	33.34	33.33	—	—	214-289	214	See Note[3]
14	54.00	—	26.00	20.00	—	217		See Note[4]
15	48.00	28.50	14.50	—	9.00 Sb	217-440		Cerromatrix
16	55.50	44.50	—	—	—	255		Cerrobase
17	56.00	—	40.00	—	4.00 Zn	266		
18	58.00	—	42.00	—	—	281		Cerrotru
19	40.00	—	60.00	—	—	281-338	302	Cerrocast
20	60.00	—	—	40.00	—	291		
21	100.00					520		
22		100.00				620		
23			100.00			450		
24				100.00		610		
25					100.00 Sb	1167		
26					100.00 In	315		
27					100.00 Zn	787		

[1] *Alloys for which single melting points are listed are eutectics.*
[2] *For eutectics, yield temperature corresponds to melting temperature.*
[3] *Special alloy for anchoring bushings in machinery.*
[4] *Alloy used in selenium rectifiers.*
[5] *All Cerro alloy designations except Cerrocast are registered trade marks. Cerrocast is a trade mark.*

generally used for this purpose. Split jaw chucks of most complicated shapes can thus be made easily in only a few hours at a small fraction of the cost of machining methods of construction. Despite the relative softness of the alloy, these chuck jaws stand up for long runs. Embedded chips can be used to improve wearing quality of the working surfaces.

Cores and Mandrels

The expansion property of bismuth alloys enables them to reproduce mold detail as fine as 5000 to 7000 lines per in. Thus the bismuth alloys open fields of use too large to discuss fully here. However, the most outstanding of these is electroforming.

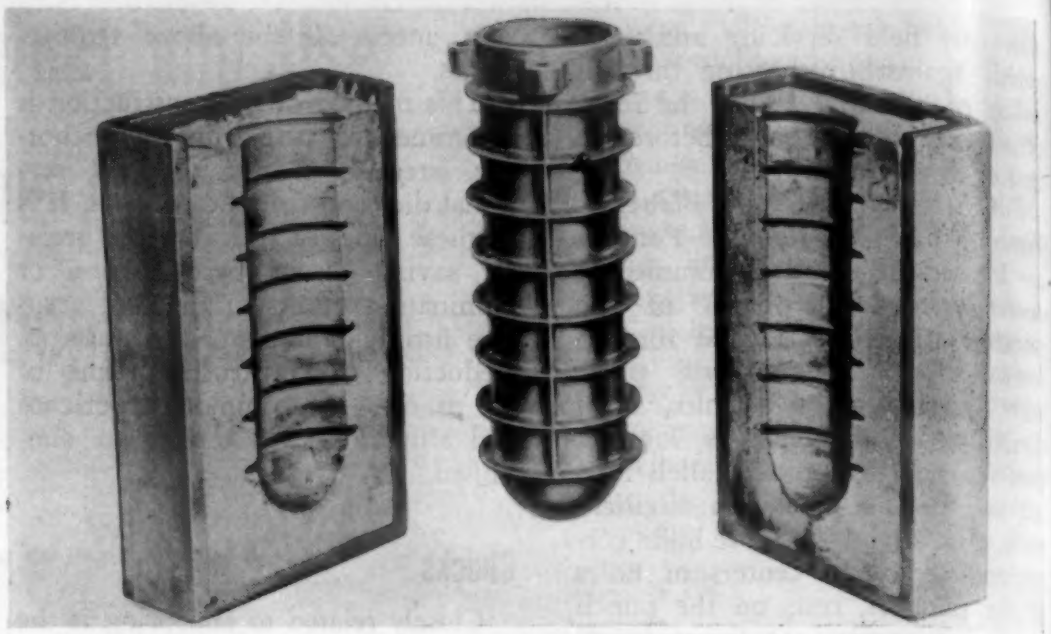
Cores for Electroforming—Electroforming, an extension of electroplating, is used to produce intricate shapes and parts that are not efficiently and accurately made by any other method. The process is widely used for production of much of the plumbing used in micro-wave communication equipment, tire molds, rubber and plastic molds, pitot static tubes, etc.

Articles of irregular patterns, with re-entrant angles or undercuts, and internal shapes requiring high accuracy of surface finish and dimensions require mandrels or cores of fusible metal to facilitate removal after the electroforming process is completed. First, an accurate mold must be made for casting the fusible alloy cores. This mold is heated to somewhat less than the melting temperature of the alloy used to cast the cores, and the low-melting alloy is poured into the mold and solidified. A conductive parting medium is applied to the core and the desired metal is electrodeposited to proper thickness. When electroforming is completed, the core is melted out.

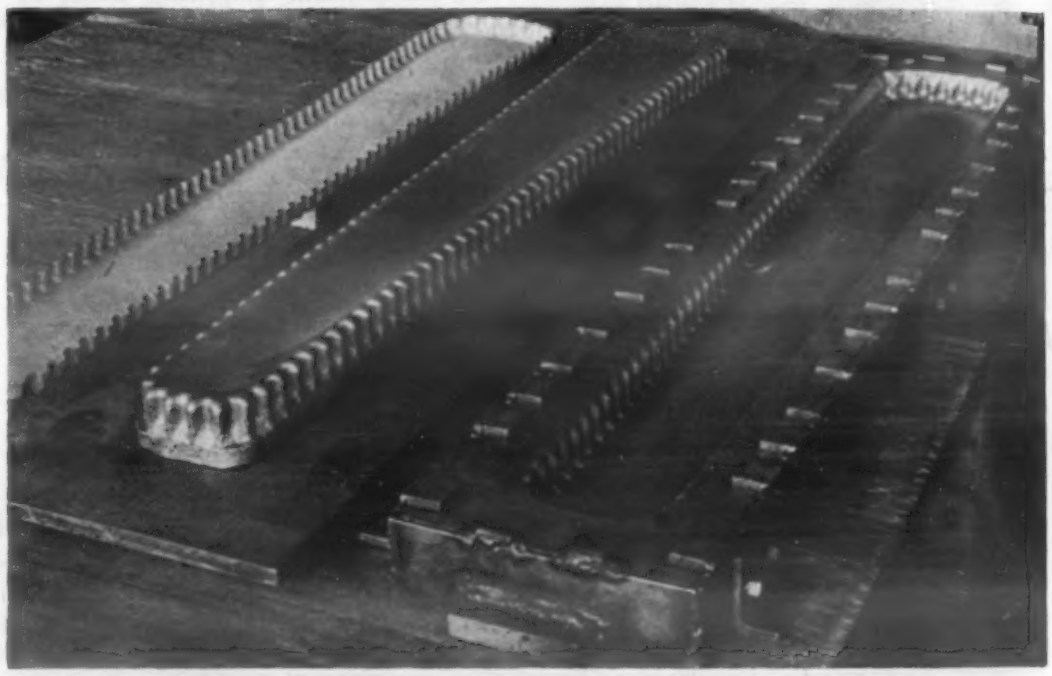
The high dimensional and surface finish requirements of electroforming demand fusible alloys of positive expansion to assure pick-up of all detail. Alloys for this purpose must also be free-flowing to assure clean removal when melting out. The eutectic alloys, 16 (Cerrobase) and 18, are the two most generally used in this application. The latter is gaining in favor because of its greater dimensional stability, permitting closer tolerances on precision parts.

Dies and Punches

Ease of handling, accurate reproduction of patterns, and full salvageability for repeated re-use make several bismuth alloys useful in forming sheet metal. The low-melting alloy die can be used with a rubber punch (Guerin Process); one alloy can be used for both die and punch or a matrix alloy die can be used with a punch made of an alloy of a lower melting temperature. A recent development of the Ford Motor Co. involves chilling low-melting dies with liquid nitrogen to increase their hardness, making possible the forming of heavier gages of steel. This development has cut weeks off the time required to make such dies for experimental purposes.



Cast bismuth alloy split jaw chucks hold die cast part (center) during machining.



In this die set for forming light gage stainless steel, Alloy 15 die serves as a mold for Alloy 16 punch. (Courtesy Fleetwings, Inc.)

Drop Hammer and Short Run Forming and Embossing Dies—The pattern for the part can be made of clay, metal, plaster, plastic or wood. A sheet metal mold box built around the pattern will permit cold water quenching and hasten cooling, with definite improvement of the casting. A low-melting alloy is ladled or pumped into the mold box to form the die and the filled mold box is lowered into a cold, circulating quench tank. The punch is poured within the die to assure true fit. Allowance for metal thickness is easily made with casting plaster. A mixture of dry clay and clear lacquer, applied with a paint spray gun until metal thickness is built up, provides both allowance for metal thickness and heat insulation.

This type of application is generally based on short run production; hence extremely hard metal is not necessary. However, longer runs can be obtained if steel inserts are incorporated in the dies at wear points. Low pouring temperature for speed and safety in handling, together with non-

Table 2—Properties of Several Widely Used Bismuth Alloys

Alloy Designation / Properties	1 Cerrolow-117	2 Cerrolow-136	3 Cerrobend	6 Cerrosafe	15 Cerro-matrix	16 Cerrobase	18 Cerrotru	19 Cerrocast
Yield Temp. F	117	136	158	162.5	240	255	281	302
Weight, Lb./Cu. In.	0.32	0.31	0.339	0.341	0.343	0.380	0.315	0.296
Tensile Strength, Psi.	5,400	6,300	5,990	5,400	13,000	6,400	8,000	8,000
Elong. in 2 In. (Slow Load), %	1.5	50	200	220	<1	60-70	200	200
Brinell Hardness	12	14	9.2	9	19	10.2	22	22
*Spec. Heat (Liquid), Btu./Lb./deg. F	0.035	0.032	0.040	0.04	0.04	0.042	0.045	0.047
*Spec. Heat (Solid), Btu./Lb./deg. F	0.035	0.032	0.040	0.04	0.045	0.03+	0.045	0.047
*Latent Heat of Fusion, Btu/Lb.	6	8	14	10		7.2	20	22
*Coeff. of Thermal Expan., per deg. F	—	—	1.2×10^{-5}	1.3×10^{-5}	—	—	0.9×10^{-5}	0.9×10^{-5}
Elect. Cond., % of Copper	3.9	3	4	4	3.2	3	4.5	4.6
*Max. Load (30 sec.), Psi.	—	—	10,000	9,000	16,000	8,000	15,000	15,000
*Max. Load (5 min.), Psi.	—	—	4,000	3,800	10,000	4,000	9,000	9,500
*Safe Sustained Load, Psi.	—	—	300	300	300	300	500	500
Cumulative Growth and Shrinkage per In. Compared to Cold Mold Dimensions. (Test Bar: ½ x ½ x 10 In.)								
Time after Casting:								
2 min.	+.0005	+.0003	+.0025	−.0004	+.0008	−.0008	+.0007	−.0001
30 min.	.0000	+.0001	+.0045	−.0009	+.0047	−.0010	+.0006	−.0001
1 hr.	−.0001	.0000	+.0051	.0000	+.0048	−.0008	+.0006	−.0001
5 hr.	−.0002	−.0002	+.0051	+.0018	+.0049	.0000	+.0005	−.0001
24 hr.	−.0002	−.0002	+.0051	+.0022	+.0051	+.0008	+.0005	−.0001
96 hr.	−.0002	−.0002	+.0053	+.0025	+.0055	+.0015	+.0005	−.0001
500 hr.	−.0002	−.0002	+.0057	+.0025	+.0061	+.0022	+.0005	−.0001

*Approximate Values.

shrinkage characteristics are essential factors to consider in alloy selection. Alloy 3 (Cerrobend) is the alloy most extensively used, especially in large die sets weighing up to 11 tons. Smaller dies and punches can be readily made from Alloys 15 or 16, and 18 is ideal for joggle press jaws.

The time and cost savings factors for experimental and short run forming dies are considerable when bismuth alloys are used. In addition, hand finishing is negligible and the metal is fully reusable when dies are discarded or worn.

Molds

Molds are required for a variety of purposes in industry and the bismuth alloys offer easily worked materials which can be adapted to a number of mold requirements. The plastics field in particular can utilize low-melting alloys for short-run or experimental molds for use with the low temperature casting resins. In the precision investment casting industry soft metal molds are used in about 50% of the cases. A brief description of some of these applications follows:

Casting Plastics, Plaster, etc.—The master pattern is located on a board or metal plate, invested in clay or plaster to the parting line (if not split pattern), and flasked. The pattern is dusted with a parting of graphite or powdered mica and polished. The low-melting alloy is poured over the pattern to fill the flask to the desired depth. The investment is then removed and the second half poured. Activators in some plastics react with metals; therefore an insulating parting medium must be applied to the mold surface before casting plastics. Since higher-melting alloys offer the broadest range of usefulness, Alloys 16 and 18 are preferred. Complete salvageability plus minimum production cost make this method desirable especially for experimental or trial runs.

Lost Wax Pattern Molds—Hydraulic pressure casting is the most common method of producing soft metal molds. The master pattern is embedded to the parting line in a matrix, usually plaster, and placed in a hydraulic chamber with the pattern facing upward. Molten alloy is poured into the chamber to the desired depth, and pressure, upwards of 5 tons, is applied. After solidification, the matrix is removed, and the process repeated to complete the mold. Complicated shapes may require repetition of pouring and pressing if there is more than one parting line.

Precision investment casting offers the only method of production of certain shapes in some of the casting materials, particularly the so-called non-machinable metals. A low pouring temperature for easy handling and ease of coining, plus hardness for wearing qualities, are required. The injection temperatures of wax usually rule out soft metals melting below the temperature of boiling water.

Alloy 19 (Cerrocast), an off-eutectic, with nearly zero shrinkage is easily coined to reproduce fine detail at unusually low pressures and its hardness assures relatively long production runs. Alloys 18 and 16 and occasionally 3 are also used for soft metal molds.

Models and Patterns

There are many occasions when a quickly and accurately produced duplicate of a pattern or part is required. Ordinary duplicating materials are subject to shrinkage when cast and allowances must be made for this factor. The non-shrinking bismuth alloys are widely used for duplicate models and patterns at great savings.

Master Patterns for Match Plates—The wood master pattern is located on a mold board and flasked. Lycopodium parting is followed by about ¼ in. facing sand and filling with fine Albany sand. Plaster or wood molds can be used if desirable or more convenient (plaster should be thoroughly dried). Pouring temperature should be kept as low as possible but must be increased for thin sections. Filling

thin sections requires a free flowing metal that is non-shrinking. Both Alloy 16 and 18 are widely used.

Non-shrinking low-melting alloys assure positive duplication of a master pattern of the highest accuracy. Low pouring temperatures and good reproduction of fine detail eliminate expensive clean-up and chasing, common to other duplicate pattern metals.

Miscellaneous Production Tooling

Numerous other ways of using the bismuth alloys as production aids have been worked out. Included are their use as special low-melting solders; heat transfer media in constant temperature baths; seals for bright annealing and nitriding furnaces; seals for adjustment screws on instruments, torque wrenches, etc.; forming blocks; hold-down clamp pads and several others. Two outstanding production tooling uses are described below.

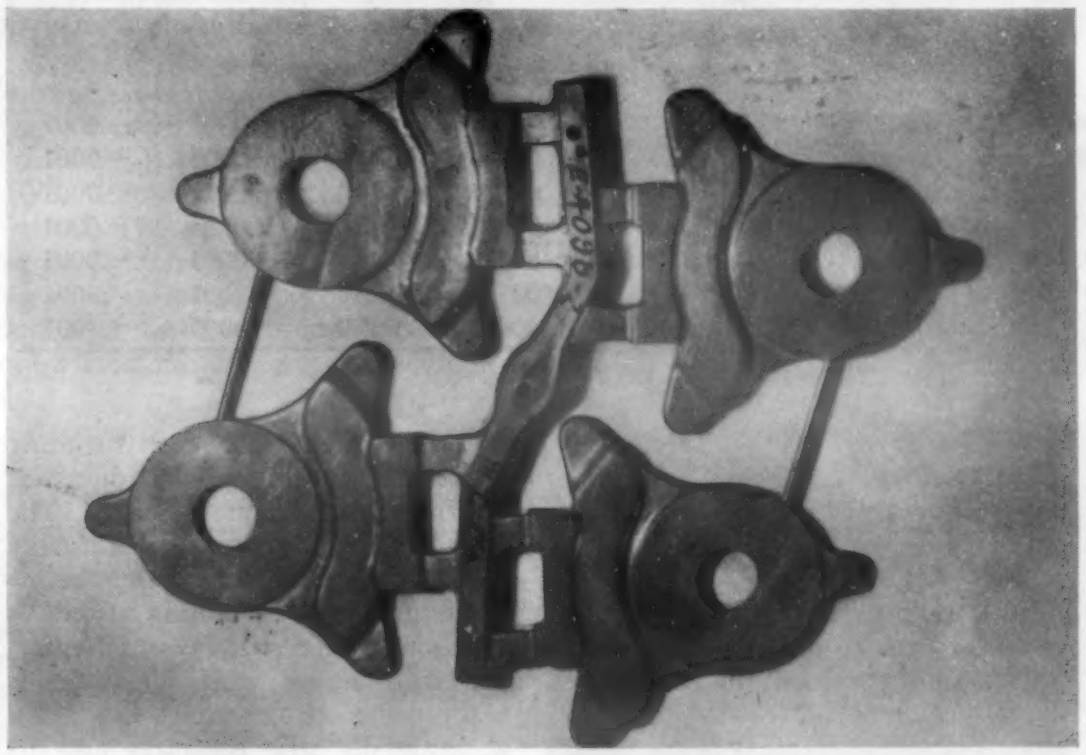
Bending Thin-Walled Tubing, Moldings and Extruded Shapes—Thin-walled tubing requires internal support during bending to prevent buckling, wrinkling or flattening. First the tube should be fully annealed and thoroughly cleaned out to remove scale and dirt. One end is plugged and the inner walls coated with light lubricating oil. The tube is filled with a low-melting alloy, poured at the lowest temperature that will produce no cold sets. The tube is immediately quenched in circulating cold water and then rewarmed to room temperature. The filled tube can be bent or formed and the alloy filler melted out in boiling water and reused repeatedly.

The alloy should have a melting point below the temperature of boiling water for ease in handling and should be free-flowing when melted to assure easy removal. It should expand slightly when solidified to assure a tight fit. Furthermore, its ductility must be higher than that of any material in which it is to be used. Alloy 3 is preferred for tubing up to 1¾ in. dia. The slow cooling in larger diameter tubes results in grain growth and consequent loss of ductility. For large tubes, Alloy 16 is used as its grain size and ductility remain fairly constant. This alloy must be melted out in a hot oil bath.

The low melting alloy also serves as an inspection gage, as its expansion would bulge or burst defective tubes. Unlike rosin, these alloys offer no fire hazard.

Fixtures for Assembly, Checking and Die Spotting—The starting point is a master model or mock-up whose outside dimensions correspond to the inner dimensions of the metal part. A supporting frame of mahogany, plaster reinforced with soft wood, or welded tubular and perforated sheet metal construction is built to conform to the master model within about ¼ in. Lattice or rib construction is used for lightness. All rack surfaces facing the model are studded with tacks or staples projecting about ⅛ in. to provide anchorage. Rack and model are then placed together, all openings closed with clay and/or plaster, and pouring funnels and vents are located. A low melting alloy is poured into the space between rack and model. The solidified metal gives the rack a veneered working surface the exact reverse of that of the model. Such fixtures are widely used in the aircraft and automotive industry.

This application requires an alloy having slight expansion and low pouring temperature. It is also important that the casting medium be capable of reproducing fine detail, such as scribe and layout marks. Alloy 3 is used because its low pouring temperature causes no vaporization when poured against wood or partly dried plaster.



Four Cerrobase duplicates of wood master pattern soldered to brass runner form multiple pattern for a matchplate. (Courtesy Mergenthaler Linotype Co.)

A non-shrinking, low-melting alloy was used to produce accurate surface on die spotting fixture from master model in background. (Courtesy Castaloy Metal Sales Co.)

Materials & Methods Manual

This is another in a series of comprehensive articles on engineering materials and their processing. Each is complete in itself. These special sections provide the reader with useful data on characteristics of materials or fabricated parts and on their processing and application

62

Ceramics for Engineering Applications

by John H. Koenig, Director, School of Ceramics, Rutgers University

Technical ceramics have a set of properties that make them valuable engineering materials in the electrical and electronics field, the chemical and process industries, and in many special purpose and high temperature applications. This manual gives the engineer a comprehensive picture of technical ceramics—what they are, what they can and cannot do, and where they are being used—so that he can intelligently select and apply them in his products.

Contents

Introduction . . . . . Page 70
General Properties and Characteristics . . . . . Page 72
Ceramics for the Electrical Industry . . . . . Page 74
Heat Resistant Ceramics for Normal and High Temperatures Page 77
Ceramics for the Chemical Industry . . . . . Page 82
Special Purpose Ceramics . . . . . Page 84

Important Definitions

Ceramic Whiteware—A fired ware consisting of a glazed or unglazed ceramic body that is commonly white. This is a generic term comprising chinas, porcelains, earthenwares, and others.

Porcelain—The glazed or unglazed vitreous ceramic whiteware as used for technical purposes. This includes such products as electrical insulators, and chemical, mechanical, structural and thermal (vitrified) wares.

Calcine—A ceramic material or mixture fired to less than fusion for use as a constituent in a ceramic composition.

Flux—A substance that promotes fusion in a given ceramic mixture.

Glaze—A coating matured to the glassy state on a formed ceramic article, or the material or mixture from which the coating is made. A *raw glaze* is compounded primarily from raw ingredients while a *fritted glaze* has a portion of the composition prefused and referred to as a frit.

Vitrification—The progressive reduction in porosity of a ceramic body as a result of heat treatment, or the process involved. The porosity is normally measured as absorption, the percentage relationship of the weight of water absorbed to the weight of the dry specimen after a specific immersion treatment. The degree of vitrification is normally expressed with such terms as highly porous (>10% absorption); semivitreous (3 to 10%); technically vitreous (0.5 to 3.0%); and vitreous (<0.5%). For ceramic dielectrics less than 0.1% absorption is generally specified.

Maturing Range (vitrification range for vitreous bodies)—The time-temperature range within which a ceramic composition can be fired to yield specific properties.

Cone Temperature—Bodies are referred to as being matured at a specific cone. A cone is a trihedral pyramid made of a mixture of materials as used in classical bodies. Thus, they behave similarly (thermochemically) and provide useful pyrometric guides for the proper firing of ceramics in terms of time and temperature. For convenience of the reader not acquainted with cone usage, the corresponding temperature in F is given for a rate of temperature increase of 68 F per hr.

Loss Factor—The loss factor of an insulating material is defined as the product of its dielectric constant and the tangent of its loss angle (the tangent of the loss angle is considered equal to the power factor, for materials covered by Joint Army-Navy Specification JAN-I-10).

Te Value—The temperature at which the resistivity of the material being tested becomes one megohm centimeter.

Introduction

Several decades ago the typical ceramic body, as made for centuries from clay, feldspar and flint, generally met the consumer requirements for technical ceramics in the different fields. However, during recent years service requirements have become more exacting and many special ceramics have been developed to obtain vast improvement in one or more specific properties for particular applications. These new developments have involved new types of materials and improved methods of fabrication, and their continually increasing use as engineering materials is noteworthy.

The purpose of this manual is to give the engineer an appreciation of technical ceramics, and to describe their properties and limitations so that proper selection and application of these materials can be made.

The technical ceramics discussed in this manual include: those ceramics required by (1) the electrical and electronics industries (electrical porcelain, spark-plug insulation and ceramic dielectrics for electronic equipment); (2) various types of ceramics required by the chemical industries; (3) heat resistant ceramics for normal and high temperature uses; and (4) a number of other ceramics for special or specific applications. These technical ceramics represent only a few of the wide range of products designated as ceramic whitewares.

Nature and Composition

The classical ceramic whiteware body is composed essentially of a flux, a plastic, and a non-plastic. The nonplastic provides the skeleton held together by the glass phase (or bond) developed from the flux on firing. The plastic content, normally imparted by plastic clays and at times by organic additives, provides for workability and castability required in the normal forming methods.

In general, more than one source of the same type of material is used. The desired workability or castability is normally obtained from the prop mixture of clays to give the desir particle-size distribution. Relatively r cent air classification of clays has pr vided for better control of particle si distribution. A simple method of co pounding a body of specific properti consists of first determining the plasti nonplastic ratio providing the desir workability, then adding flux in i creasing amounts to attain the desir density for the firing conditions.

The general composition of typic whiteware bodies can be learned fro the classical formulas given in Tab 1. Many of the special ceramics di cussed in this manual constitute de partures from the classical, *e.g.*, bodi with little or no plastic clays, bodi essentially of single oxides, and bodi with no glass phase. The compositi and fabrication techniques for th will be related under the specific di cussions of these ceramics.

Other materials, *e.g.*, talc and pyr phyllite, have been used in the classic type porous bodies. Increasing emph sis has been given to obtaining low maturing bodies, the use of more acti fluxes, combination of fluxes, high flux content, and especially more fine ground raw materials, providing mea for lower firing. Any higher cost raw materials is offset by fuel a refractory economies. A number vitreous bodies have been develope which vitrify at relatively low tem peratures. A cone 4 (2129F) vitreo body is being produced largely fro nepheline syenite. Nepheline syeni talc mixtures provide fluxes for vitrifi bodies maturing in the firing rang cone 02 to 2 (2003 to 2075F). Nephe line syenite-talc-spodumene mixture have been recently recommended fo fluxes for low temperature vitreo bodies. The firing temperature of normal cone 10 (2300F) china com position can be lowered by two t three cones (95 to 120F) by replacin the feldspar content by nephel syenite. As already indicated, oth material advances will be discusse under specific ceramics.

Table 1—General Composition of Some Ceramics

	Chemical Porcelain	Normal Porcelains	Electrical Porcelains	Vitreous China	Sanitary Porcelain	Fine Earthenware
	Cone 12-14 (2390-2534F)	Cone 12-14 (2390-2534F)	Cone 11-13 (2345-2462F)	Cone 10-11 (2300-2345F)	Cone 9-11 (2282-2345F)	Cone 8-9 (2237-2282F)
Feldspar or Nepheline Syenite	20-25	20-28	28-38	10-18	30-36	10-16
Whiting	0-1	0-1	0-3	0-1.5	—	—
Dolomite	—	—	—	0-3.0	—	—
Ball Clay	0-5	—	15-35	10-20	16-25	20-35
Kaolin, China Clay	50-58	40-50	20-35	20-30	20-30	20-35
Silica (200 Mesh "Flint")	10-15	22-35	15-25	30-38	20-30	32-36

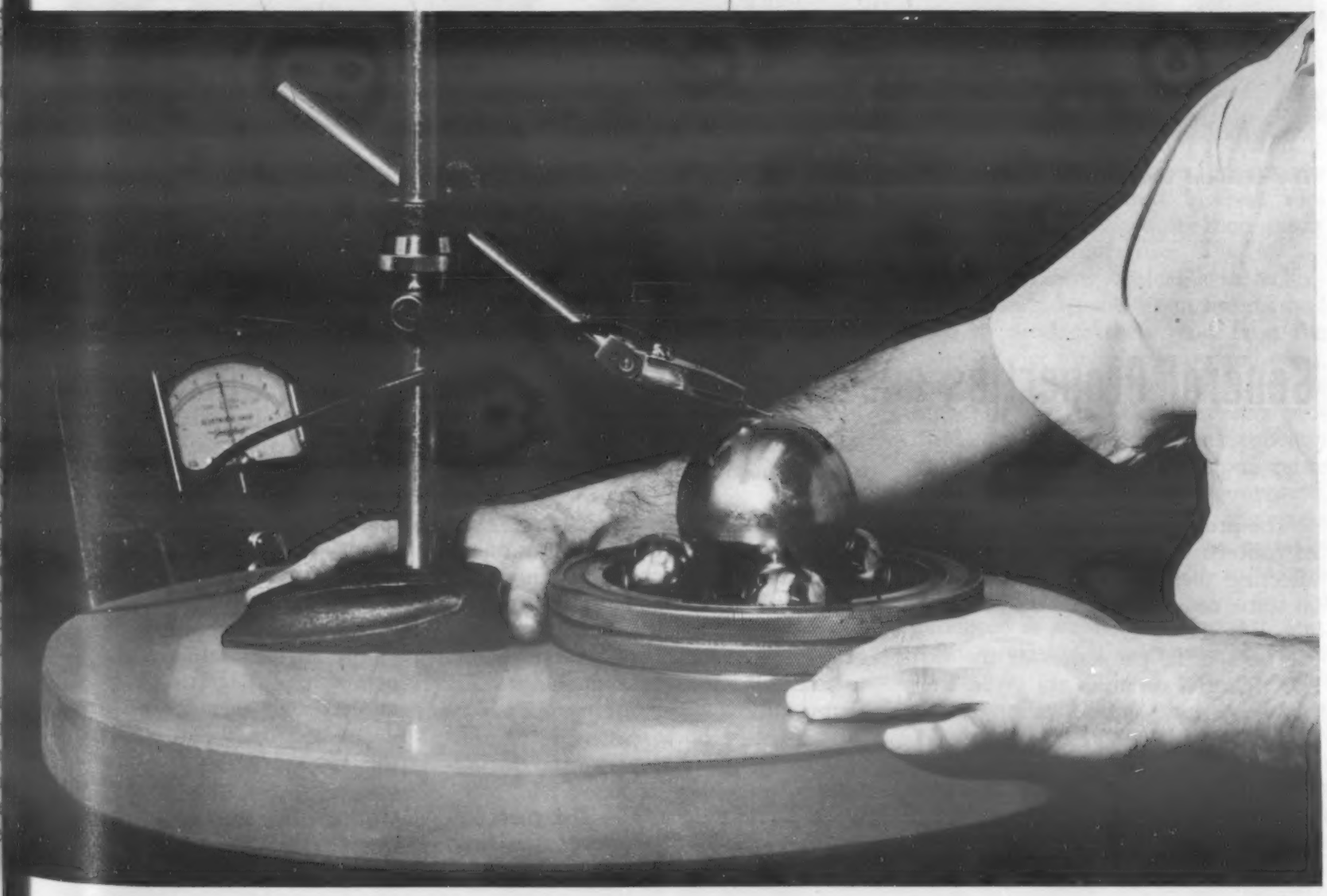
ethods of Production

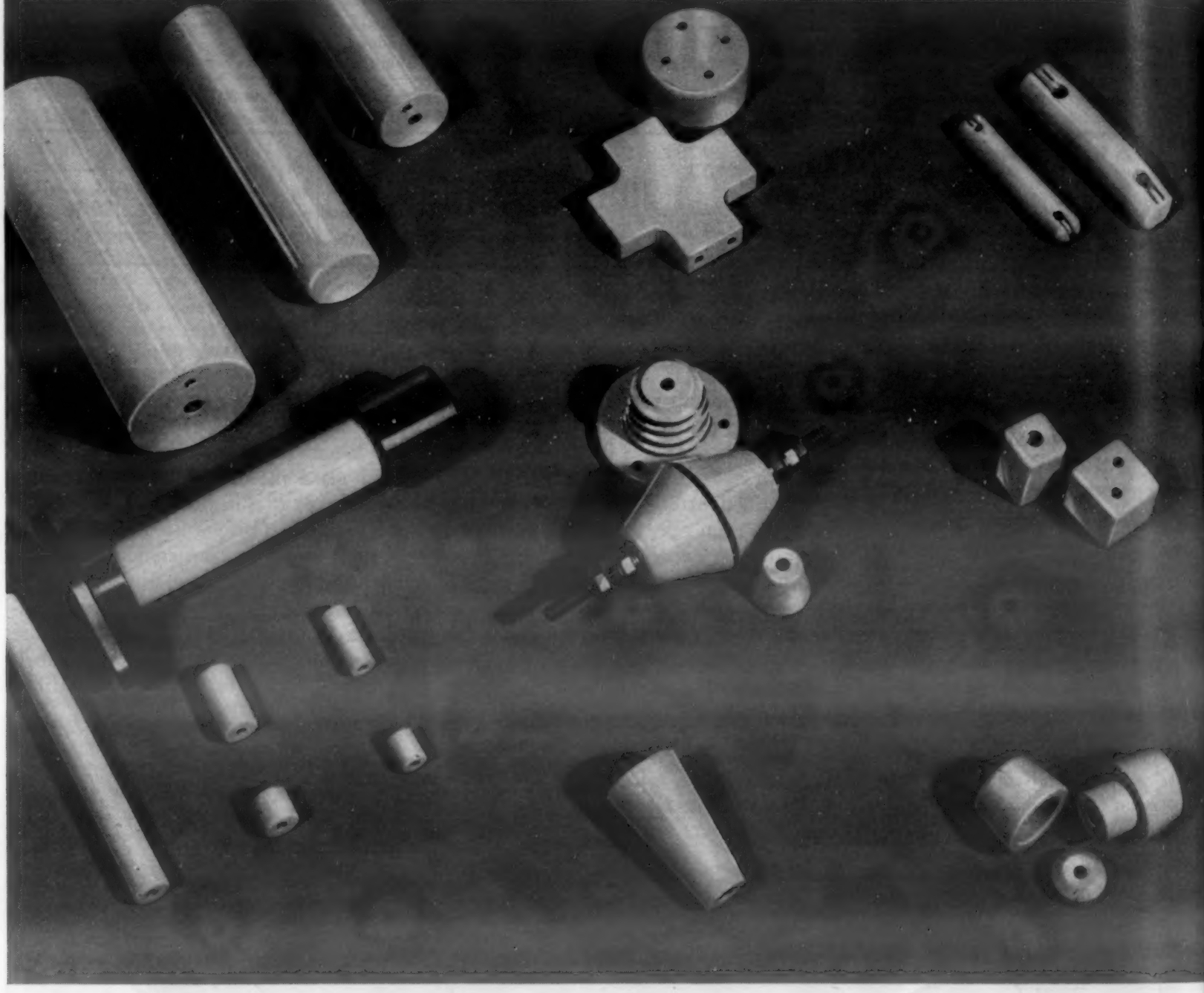
The principal methods of forming amic shapes from the prepared body mposition are referred to as jigger-, casting, extruding, and pressing. A ishing operation generally follows, ich can vary from only inspection to ricate machining in the dried state, pending on the product.

Jiggering, now largely automatic, is st brought to mind by the old pot-'s wheel. In casting, a suspension the body composition is poured into gypsum mold which absorbs mois-e, building up a shape to the desired thickness, and the excess is poured off (drain-casting); some items are cast solid. De-airing pug mills are used in extruding a number of products which are suitable in shape. Pressing, especially with hydraulic or automatic presses, has gained extended use where adaptable. In each operation close control is required as needed to attain necessary workability or castability. The properties of the fired ceramics will vary with forming operations as they affect the density of the pre-fired shapes.

The formed ceramic is referred to as being in the "green" state and, when subsequently dried, to the "leather-hard" state. If the ceramic is to be glazed, the glaze of proper consistency and composition can then be applied (normally sprayed on), and the body and glaze matured in a single firing; sometimes it is desirable to mature the body first (bisque-fire), apply the glaze of proper consistency and composition for a subsequent lower temperature firing (glost-fire), which matures the glaze on the body. More reference will be given later to fabrication techniques where they differ from the normal operations.

e of the newest uses of ceramics is for surface plates for gages, tools and instruments. Ceramics for such applications have many advantages r those made of cast iron, granite, etc. They wear many times longer than other plates, stay flat, are easy to clean, will not corrode, and require no special care. (Courtesy Norton Co.)





The excellent electrical insulation qualities of ceramics ideally suit them to many uses in the electrical field. Here are but a few of t variety of insulators generally available. (Courtesy American Lava Corp.)

General Properties and Characteristics of Technical Ceramics

The properties of technical ceramics of concern to the user and conditions affecting these properties, as outlined in some detail by S. J. McDowell, are given in Table 2.

The specific properties of the various technical ceramics are given later; however, some generalization can be made here.

Chemical Resistance—Practically all ceramic products have high chemical resistance, being relatively inert to all chemicals except hydrofluoric acid and, to some extent, hot caustic solutions. Chemical porcelain, stoneware, glass, and glass-lined steel fulfill most of the requirements for chemical equipment and handling of chemicals. All technical ceramics will withstand prolonged heating at a minimum of 1830 F, and many will withstand higher operating temperatures, *e.g.*, the refractory porous and vitrified bodies as used for radiant heaters, burner parts, and pyrometer tubes.

Strength Properties—The mechanical strength of ceramics varies considerably, depending on composition and degree vitrification. Ceramics a normally much stronger under co pressive loading than in tension. T stress condition of the outer laye greatly affects the strength. For e ample, the flexural and tensile streng of a normal porcelain can be increas or decreased as much as 40 or 50 depending on the stress condition the glaze. The thermal expansion the body, and the effects of volu changes due to inversions, are impo tant to consider in designing the gla so that it is under the optimum str

Table 2—Significant Properties of Technical Ceramics and Factors Affecting Them

Property	Conditions in Ceramic Affecting Properties
Mechanical and Physical Specific Gravity Water Absorption Color Hardness Resistance to Abrasion Softening Temperature (Also Thermal) Tensile Strength Compressive Strength Resistance to Impact	Individual Mineral Constituents 1. Chemical compositions 2. Character of crystals a. Shape and size of individual crystals b. Cleavages of individual crystals c. Coefficient of elasticity of individual crystals Glass Phase 1. Chemical composition 2. Coefficient of elasticity Relation of Crystal to Glass 1. Equilibrium attained and ratio of crystal to glass phase a. Firing time and temperature b. Rate of cooling c. Atmosphere 2. Wetting power of crystal and glass Homogeneity 1. Fineness of grinding 2. Mode of addition of minerals 3. Method of preparation 4. Firing conditions Glaze Frit
Thermal Coefficient of Thermal Expansion and Uniformity of Curve Heat Conductivity and Diffusivity Softening Temperature (Also Mechanical) Te Value (Also Electrical)	1. Chemical composition of crystal and glass phases 2. Coefficients of expansions and elasticity of each 3. Bond between glass and crystals 4. Size of crystals 5. Glaze rit 6. Homogeneity 7. Porosity 8. Firing cycle
Electrical Dielectric Strength (Puncture Voltage) Te Value (Also Thermal) Power Factor Dielectric Constant Capacity Change per Degree C	1. Chemical composition 2. Mineralogical constituents 3. Electrical properties of both crystals and glass 4. Porosity 5. Surface
Chemical Resistance to Acids and Alkalies Operation as Contact Agent in Catalysis Permeability Filtering Properties	1. Chemical composition of crystal and glass phases 2. Ratio of crystals to glass 3. Size of crystals 4. Homogeneity 5. Firing cycle of body 6. Porosity and size of pores

ondition (compression) and, consequently, the maximum (practical) in in mechanical strength and thermal endurance of the ware is attained. number of the ceramics have very igh mechanical strength and compare vorably with some metals.

Electrical Properties—Ceramic insulation in use for electrical applications might be classified as low-voltage nd high-voltage electrical porcelain, igh frequency insulation (low dielectric loss), and high dielectric constant eramics (capacitor dielectrics). For ost electrical applications high mechanical strength, good thermal endurance, and high dielectric strength e required. These and other requirements are fully met in the presently vailable ceramics.

Abrasion Resistance—Dense, high-fired ceramics are hard and have high abrasion resistance. A few applications in which this property is used to advantage are grinding media and linings for mills, blasting nozzles, precision gages, extrusion dies, and thread guides.

Joining—The most common and widely used means of attaching and joining ceramics in assemblies is by mechanical means. However, with the recent trend toward miniaturization in the expanding field of electronics, considerable improvement has been required and achieved in glass-to-metal and ceramic-to-metal seals. As the physical size of the component is decreased, the stresses on the component parts necessarily are increased. Many electronic components require hermetic sealing. The present ceramic-to-metal seals can be divided into five general classes: matched seals, unmatched seals, soldered seals, brazed seals, and mechanical seals. Great improvement has been made in all types during the past several years.

Design Considerations—In general, ceramics for engineering applications are received from the manufacturer in finished form and ready to be used without further processing. Parts of almost any shape and size are available, ranging from extremely small intricate shapes to large bulky parts as large as 10 to 20 ft.

Although space does not permit a detailed discussion of design considerations, it is worthwhile to mention a few of the more important ones. There are no definitely established limits on wall thicknesses. For practical purposes walls are held to a thickness which minimizes ellipticity during firing of the part. This minimum thickness varies with the size of the part, the production method, and the type of ceramic.

The minimum thickness of flat plates or surfaces subject to warpage during firing depends on the method of production. In general, however, the minimum thickness should be ⅛ in., but it is better that it be ¼ in. or more. As the surface area increases, the minimum thickness, of course, also increases.

Although intricate ceramic parts can be had when necessary, it should be obvious that the simplest forms possible should be designed. For example, parts with many different variations in level and thickness increase tool cost and sometimes require more costly methods of manufacture.

The tolerances attainable in technical ceramics depend upon the method used to produce them, and as is the case in other material forms and parts, the closer the tolerances required the higher is the cost. Ceramic parts produced by extrusion and subsequently machined can be held to a tolerance of ± 1% of the dimension involved. Parts manufactured by the wet press method have broader tolerances, ranging from 0.015 to 0.020 in. Often small, automatic press parts can be produced to a tolerance of ±0.025 in.

In precision work requiring fine tolerances of ±0.005 in., precision grinding is necessary, and this involves advance techniques and is expensive.

For more detailed information on tolerances and other design data, refer to American Standards Association standard C75.2—1943 (superseded by JAN-I-8).

Ceramics for the Electrical Industry

The Joint Army-Navy Specification, JAN-I-10, covers ceramic insulation materials, *e.g.,* steatite, porcelain, glass, and glass-bonded mica; these are all Class L materials. The various grades of Class L ceramic insulating materials are as follows:

Grade	*Loss Factor*
L-1	0.150
L-2	0.070
L-3	0.035
L-4	0.016
L-5	0.008
L-6	0.004

The dielectric constant of a material of any grade shall not exceed 12.

Normal electrical porcelain would be Grade L-3, steatite Grade L-4 or Grade L-5. Grade L-4 or better is desirable for most high frequency insulation applications.

Electrical Porcelains

The so-called low-voltage porcelain, for general insulation use for 60-cycle, 110-v. a.c. applications, is basically a classical clay-flint-feldspar or nepheline syenite body, although pyrophyllite, and auxiliary fluxes are sometimes employed. When fired cone 10-12 (2300 to 2390F), the technically vitreous product is composed of mullite and undissolved quartz, bonded by a glass phase. Properties of typical low-voltage porcelain are given in Table 3.

The dry-press process, involving pressing (hydraulic presses) of the granulated composition, is most used. In some cases de-airing is resorted to during pressing to give a denser structure and, consequently, a stronger body on firing. De-airing during pressing has found increasing use. De-airing during extruding has been practiced for many years.

High-tension porcelain is vitrified, a typical composition being: 30 kaolin, 20 ball clay, 30 feldspar, and 20% silica. In order to insure high dielectric strength the absorption must be less than 0.1%; this ceramic must be suitable for voltages from 500 to the highest attainable. It must also withstand extremes of climatic conditions. The ware, such as line insulators (pin and suspension types) and strain insulators, is glazed in a single-fire with a high compression glaze.

The normal fabricating methods are employed, plastic-forming, pressing, casting, and hot-pressing (use of a heated, rotating internal form tool for hollow shapes).

Electrical porcelain finds use for: resistor spools, switch bases, terminal blocks, lead-in bushings for transformers and capacitors, among others, as well as insulation for high-voltage transmission lines.

Ceramic Spark-Plug Insulators

The development of spark-plug insulators from the early classical bodies through the present alumina type bodies coincides with the progress made in the internal combustion engine and fuels. The characteristics of the spark-plug insulator, in order of importance, are: (1) good dielectric properties at elevated temperatures, (2) high dielectric strength, (3) good thermal conductivity, (4) good resistance to heat shock, (5) high mechanical strength, (6) resistance to lead compounds, (7) low dielectric constant, (8) resistance to abrasion, (9) resistance to attack by carbon, and (10) low modulus of elasticity.

The earliest spark-plug porcelains (similar to classical bodies) contained some quartz and feldspar which resulted in relatively poor thermal endurance and electrical leakage at high temperatures. The compositions have been progressively altered to meet the increasingly more vigorous performance requirements imposed by more severe thermal and mechanical stresses on the insulator. The so-called Marquardt porcelain replaced quartz by a "sillimanite" calcine. In some early spark-plug porcelains, the feldspar was partially replaced by alkaline earth materials, *e.g.,* talc, beryl, or calcines.

During World War I, the Bureau of Standards developed the well-known No. 152 spark-plug porcelain composed of: 20% $MgO{\cdot}Al_2O_3{\cdot}4SiO_2$ (cone 16, 2642 F calcine), 40% $Al_2O_3{\cdot}SiO_2$ (cone 18, 2705 F calcine), 30% kaolin, and 10% ball clay, thus eliminating both the quartz and feldspar as used in the earlier classical compositions. This body was single-fired at cone (2642 F) using a hard porcelain gl This development had a great effect the improvement of this type of bo by the various spark plug manuf turers.

Following World War I, most of t bodies used were either of the mull or zircon type. The so-called "sil manite" calcine was found to be m lite. The theoretical mullite formati from typical compositions used appro imated: early classical electrical porc lain 34% mullite; World War I spar plug porcelain, 43% mullite; and au motive spark-plug porcelain (1935 70% or more mullite. The mulli calcine in one case was replaced by fused product consisting of mullite a a glass, and in another by the miner and alusite of the sillimanite group.

The zircon type of spark plug bo developed during the same period h been classified according to the amou of zircon added: low, about 20% medium, 30%; and high, 55 to 60% Quartz and corundum found use in t low zircon body, one of the sillimani group of minerals in the medium typ The zircon type insulators, havi similar physical properties to those mullite compositions, found some aut motive use but not for the more seve requirements.

The alumina type bodies found a plication about 1935 and were us almost exclusively for aircraft engin in World War II. Such a body is a most entirely alumina to which sma amounts of flux can be added. Bodi containing more than 80% alumin (cone 15, 2570 F) and as much as 9 to 97% alumina (cone 28-32, 2939 t 3092 F) have been developed. The us of a highly sintered soda-free alumin instead of the electrically fused dens crystalline product has contributed t this development. The physical charac teristics of this type of insulator wer greatly superior to those of any pre viously produced. The alumina typ body is abrasive and difficult to fabri cate.

With changes in composition, im proved manufacturing methods, bette kiln refractories and furniture were required. The early spark-plug bodie were prepared by conventional meth

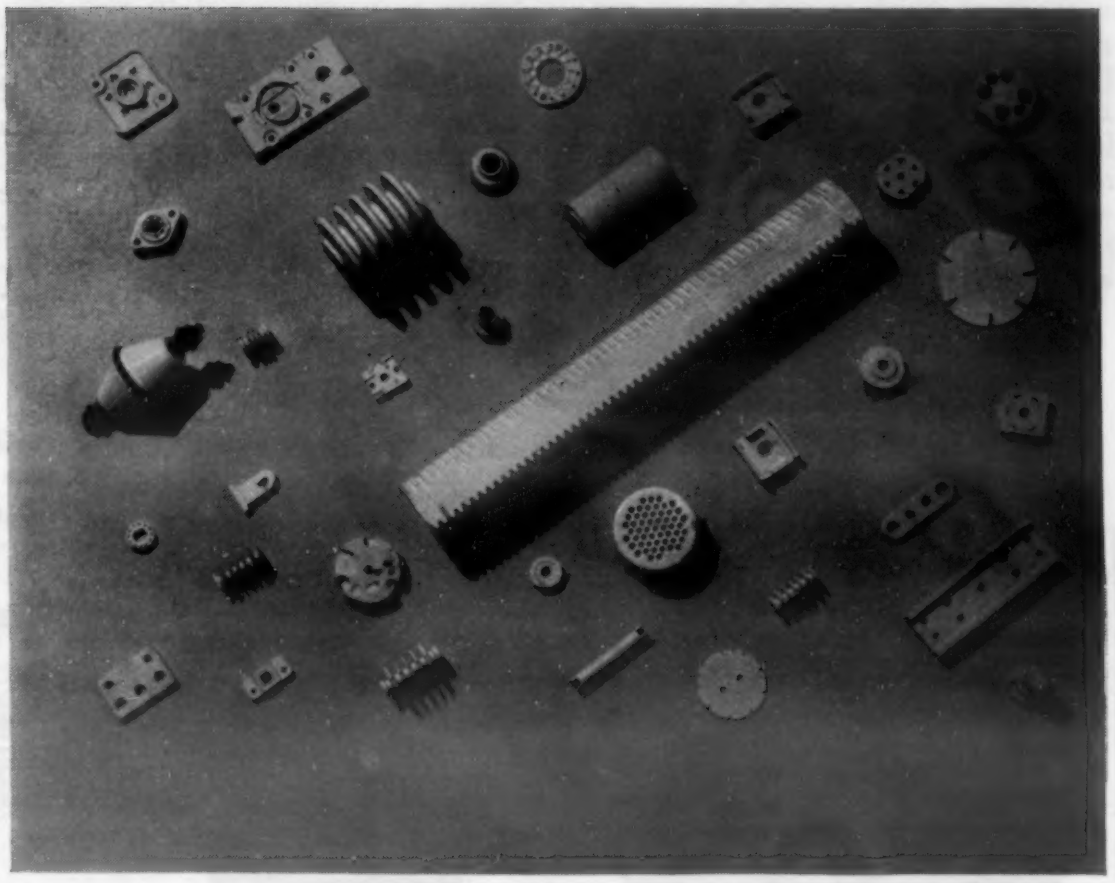
s as previously noted, the dry blank rms being turned to shape on a he. Finer ground materials, increas- elimination of clays with use of ganic binders and lubricants, and use higher firing temperatures followed. Various methods of forming non- stic bodies, *e.g.*, alumina type, have en developed such as injection mold- and slip-casting in rubber molds all pellets (spray-dried). In the in- tion molding of alumina spark-plug dies a thermo-plastic resin and plas- izer are included with the batch, ated in the cylinder to plasticizing mperature, and injected into cold ultiple capacity dies. The plasticizer d resin are driven off during the ing. Much improvement has been ained in control of firing.

Numerous compositions have been ed including: magnesia, beryllia, inel, alumina, chromium and iron ide, and combinations of these and her earth oxides. Typical physical d chemical data for a number of pes of spark-plug bodies are given in ble 4. The superior performance of e alumina type body has resulted in present wide acceptance. Besides eir principal use as spark plug in- lators these bodies have limited ap- ications elsewhere, such as in the ctronic field, and it is expected that eir use will be increased in this and her fields in the future.

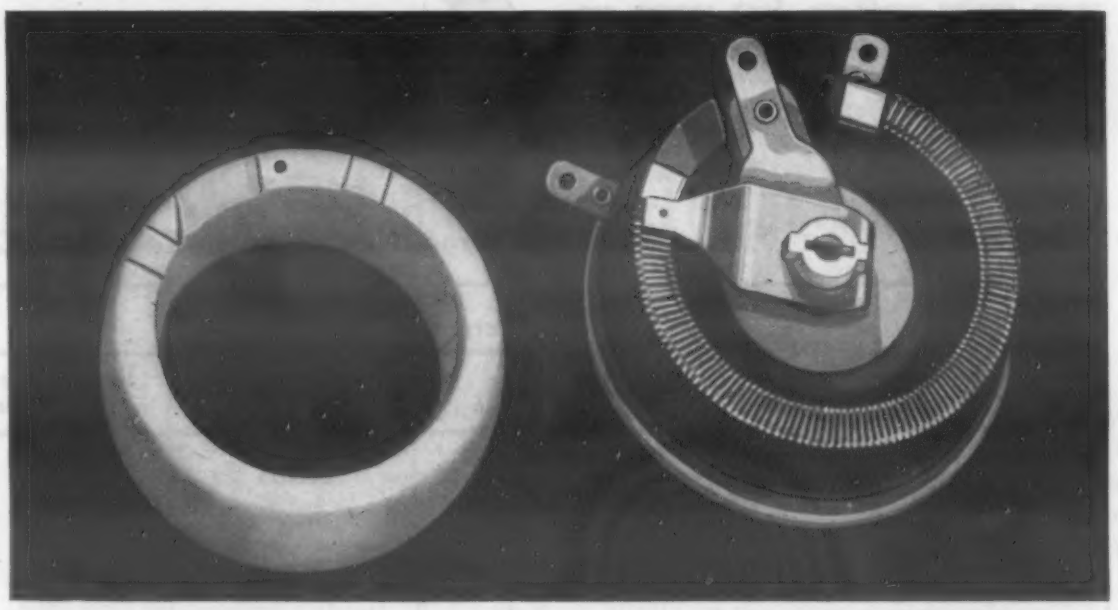
teatite Type Bodies

Steatite or steatitic porcelain is pro- uced largely from talc ($3MgO{\cdot}4SiO_2{\cdot}$- $_2O$). Talc acts as a flux but it shortens e firing range, since it decreases the scosity of the glass phase. Close fir- g control is required for high talcous odies. On firing normally to cone 2-13 (2390 to 2462 F) the principal ystal phase is clinoenstatite, and cris- balite is present in lesser amounts.

If additions of clay and fluxes are sregarded and the crystal develop- ent is complete, steatite would con- st approximately of 83 clinoenstatite nd 17% cristobalite. As a major con- tituent talc acts as a refractory; the lay and alkaline earth additions act s fluxes to give the glass bond. Both linoenstatite and cristobalite influence he properties, as do the fluxes used. The alkaline earth fluxes affect the ielectric properties but not as adverse- y as alkali fluxes (feldspar and nephe- ine syenite). Steatite is given a rapid ring to produce a maximum of small rystals and as a result a stronger body. A general formula for this type ceramic s: 70-90 talc; 0-10 kaolin, and 0-10% arium carbonate.



One of the largest users of technical ceramics is the electrical and electronic industry. Here shown are but a few of the thousands of different parts made of ceramic insulation materials. Some of the more common ceramic electrical parts include switch bases, terminal blocks, bushings for transformers and capacitors of all kinds, and insulators. (Courtesy D. M. Steward Manufacturing Co.)



The white molded ceramic part shown at left serves as the body of the assembled rheostat at right. (Courtesy Universal Clay Products Co.)

Steatite compositions, containing little or no plastic material, present problems in fabrication and have a short firing range (68F), requiring close control. The raw materials are ground together, organic binders added, and the material granulated. There are three methods of forming in general use: (1) pressing, using automatic or hydraulic presses; (2) extruding from a hydraulic press with, in most cases, subsequent machining; and (3) slip casting in plaster molds. Because of its non-abrasive characteristics, steatite lends itself to rapid accurate production of small parts on automatic presses.

Steatite is used extensively as insulators for high frequency applications because of its very good mechanical and dielectric properties and low power losses at high frequency. The thermal endurance of steatite is poor, limiting its application in cases where good heat shock is prerequisite.

Tolerance requirements of $\pm 1\%$ or nothing less than 0.005 in. are the accepted standards for pressed or ex-

truded unglazed steatite parts, but special requirements for certain critical dimensions, which are more exacting, are rather common. These are sometimes obtained by grinding, and sometimes by a 100% inspection which discards the off tolerance pieces. Close quality control must be maintained throughout all operations to insure a minimum loss in the final inspection.

The average properties of steatite for high frequency insulation are compared with other ceramics in Table 3. The loss factors for commercial steatites generally comply with grades L-4 or L-5 of JAN-I-10 Specification.

Standardized steatite insulators include: pillar insulators; lead-in bushings; spreaders and strain insulators; tube and coil forms; support bases; coupling insulators, caps, crystal cases; capacitor stators and rotors; tube spacers and envelopes; and coax

Klystron vacuum tube elements are silver-brazed to high strength, low electric loss ceramic spacers, which maintain alignment under severe service conditions. Such spacers are formed at high production rates to as-fired tolerances of 0.001 in. (Courtesy Western Gold & Platinum Works)

Ceramics form an essential part of many electrical devices. H shown is a time switch in which two white electrical porcel insulators are used. (Courtesy Clay Products Co.)

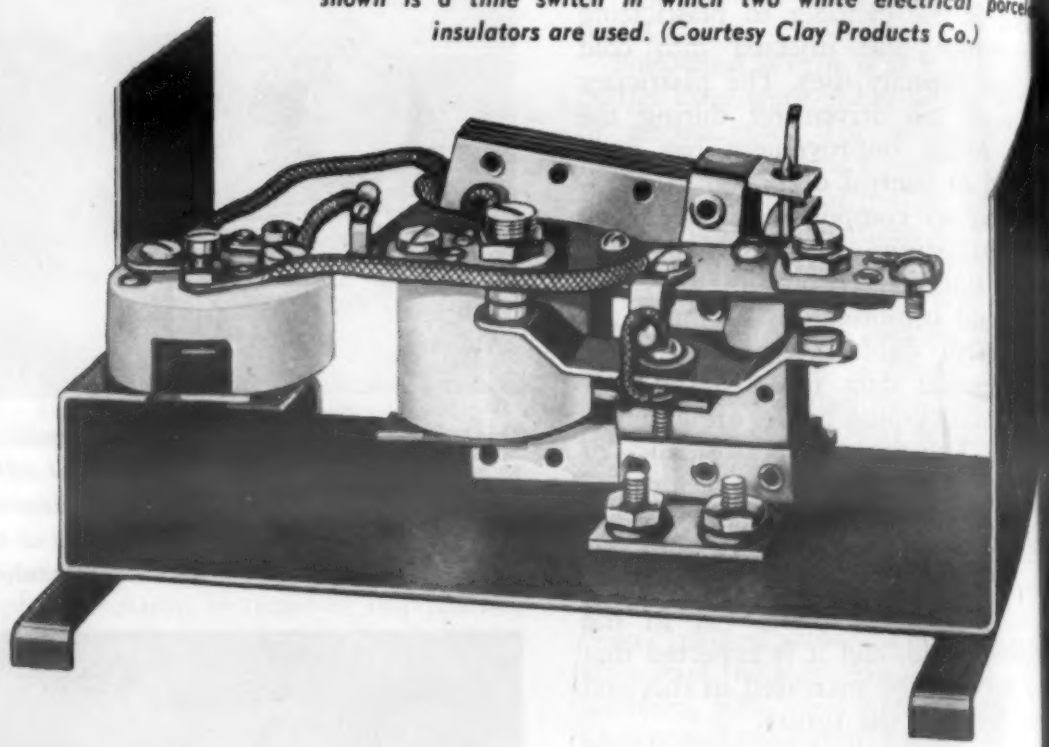


Table 3—Properties of Some Technical Ceramics

Property	Electrical Porcelain		Steatite	Zircon Porcelain	Cordierite
	Low-Voltage	High-Voltage	High Frequency Insulation	High Frequency Insulation	(Porous-type)
Moisture Absorption, %	0-1.5	0-0.03	0-0.02	0-0.01	10-15
Specific Gravity	2.4	2.4	2.6	3.7	—
Flexural Strength, Psi.	6,000	10,500	20,000	25,000	8,000
Tensile Strength, Psi.	4,000	6,000	10,000	12,700	3,500
Compressive Strength, Psi.	35,000	50,000	85,000	90,000	40,000
Impact Strength (Ft. Lb./Sq. In.)	0.9	1.5	2.0	2.1	0.9
Mohs Hardness	7.0	7.0	7.5	8.0	7
Thermal Expansion (Linear coeff., x 10^6, 77-1290F)	5.2	5.2	8.9	4.5	2.8
Softening Temperature, F	2,550	2,370	2,625	2,930	2,605
Dielectric Strength (Volts/Mil)	25	250	240	240	100
Dielectric Constant (1 MC.)	6.0	6.1	5.9	9.2	5.0
Loss Factor (1 MC.)	—	0.053	0.010	0.012	.020
Te Value, F	—	535	1,290	1,290	1,435

ble insulators.
A grade L-3 steatite is available for ousehold equipment and appliances. number of L-4 or L-5 steatites are ecifically recommended for insula- on in radio or high frequency circuits, r heater wire supports in appliances, d other applications. Steatites, be- use of their high mechanical strength, rdness and resistance to abrasion, and ease of fabrication, have considerable promise for many new applications.

Block talc, made from natural stone and frequently referred to as lava, was formerly used and still is on an experimental basis for insulators, such as tube spacers. It also has been used in the past for refractory parts. While readily machined, considerable material loss is experienced due to faults in the raw material. Commercially, the use of this material is not feasible since the hand machine work involved cannot begin to compete with automatic presses, and the synthetic bodies, *e.g.*, the alumina type, fully meet all performance requirements. The use of block talc is convenient where only a relatively few parts are required.

Table 4—Critical-Data Averages for Various Types of Spark-Plug Bodies

(According to F. H. Riddle)

Property	Triaxial[1]	Steatite	Sillimanite	Zircon	Spinel	Magnesia	Alumina 80%	Alumina 95%
Specific Gravity (Gm./Cc.)	2.4	2.6	2.5	2.9	3.2	3.3	3.5	3.6
Tensile Strength, Psi.	6,000	8,500	10,000	12,500	—	—	20,000	25,000
Compressive Strength, Psi.	55,000	70,000	130,000	140,000	—	—	205,000	290,000
Modulus of Elasticity (Psi. x 10^{-6})	12	10	16	21	—	—	35	40
Specific Heat (77 to 212 F) (Cal./Gm.)	—	—	0.19	0.18	0.20	0.23	0.19	0.19
Thermal Conductivity (1600 F) (Cal./(Cm. Sec. °C))	0.003	0.006	0.0048	0.0055	0.0076	0.0107	0.0085	0.0086
Coefficient of Expansion (77 to 1470 F) (x 10^{6})	6.4	8.0	4.6	4.7	9.7	13.9	8.5	8.5
To Value (R = 1 Megohm/Cm.[3]) (°C)	460	640	650	660	860	1060	840	1070
Dielectric Constant (2 Kc.)	6.5[2]	5.8[2]	6.2	6.8	7.5	10.0	8.4	8.5
Power Factor (2 Kc.) (%)	0.9[2]	0.17[2]	0.47	0.40	0.10	8.0	0.14	0.07
Loss Factor (2 Kc.)	5.9[2]	1.0[2]	2.9	2.7	0.75	80.0	1.2	0.6

Classical porcelain of clay-feldspar-silica
1000 kc.

Heat Resistant Ceramics for Normal and High Temperature Uses

High Thermal Endurance Ceramics

Thermal endurance (thermal shock) s an important property in many applications where temperature changes r gradients are involved, such as in arts and fixtures for heat treating, elting and brazing furnaces. The empirical formula developed by Winkelmann and Schott for evaluating the hermal endurance of glass has been pplied to other ceramics with limited uccess. There are other factors involved, including the ratio of crystalline to glass phase present, and the tress condition in the outer layers or n the glaze which influence this property to a large degree.

The effect of the glaze stress condition on mechanical strength, thermal endurance and other properties is now well appreciated. Proper "glaze fit" formerly implied the absence of "crazing"—a defect caused by tensional failure, or of "shivering" (shearing off of the glaze under excessive compression). The early thought was to have the body and glaze of similar thermal expansion or contraction so that during cooling neither defect would occur. It was first recognized (about 1918) that the ceramic was much improved by formulating the glaze to have lower expansion than the body, and to an optimum extent, which would not lead to shivering under operating practice.

The physical property which seems to govern the thermal endurance of vitrified bodies (not-glazed) is the thermal expansion. Where the thermal expansion of bodies being composed is similar, the mechanical strength tends to play an important part. The effect of different thermal conductivity, using the same size and shape of test specimens, seems to be a minor one.

As mentioned previously, steatite, which is the principal high-frequency ceramic insulation, has poor thermal endurance. A definite improvement in the thermal endurance of steatite has been attained through the introduction of barium zirconium silicate (up to 20%) in the steatite composition. This reduces the thermal expansion without affecting the physical and electrical properties (grade L-5). Progress has been made in increasing the thermal endurance of some other commonly used ceramics.

Relative thermal endurance tests on a variety of dense commercial ceramic compositions proved cordierite to be the best, followed in order by zircon, sillimanite, alumina, beryllia, electrical porcelain, and steatite. The range of failure is between 610 F and 320 F to water at room temperature.

Some polycrystalline compositions have proved quite interesting from the

Crucibles for a variety of applications are among the many refractory shapes made for use at high temperatures. (Courtesy Norton Co.)

Torch melting in a heat resistant ceramic dish. The severe thermal shock, temperatures exceeding 4000 F, and the need to maintain purity of the metal are some of the factors influencing the choice of dish material. (Courtesy Western Gold & Platinum Works)

standpoint of thermal endurance, p ticularly those containing alumi celsian, and zircon. A number relatively new ceramics possess hi thermal endurance, *e.g.*, compositio in the systems, zircon-calcium, zirco ium, silicate-clay, zircon-alumina, co positions in the field of magnes spinel, especially those containing fro 10 to 20% silica, and some lithiu aluminum silicates. Two areas of neg tive thermal expansion have be found in the lithia-alumina-silica sy tem when compositions are prepar as ceramic bodies. The thermal expa sion ranges from zero to —0.38% b tween room temperature and 1290 Several compositions have been d veloped which exhibit no change size up to 1075 F. Compositions ha ing low negative thermal expansio proved to have the highest thermal e durance, withstanding repeate quenchings from 1995 F to water room temperature. Some ceramics this system are now commercial available.

A limited number of applicatio require a ceramic possessing hig thermal conductivity, but these m become increasingly more importa with the trend towards miniaturizatio requiring greater heat dissipatio Ceramics containing 80% or mo beryllium oxide falling within t ternary systems $BeO\text{-}Al_2O_3\text{-}ThO_2$ a $BeO\text{-}Al_2O_3\text{-}ZrO_2$ have extremely hig thermal endurance. These bodies, m tured within the temperature ran 2730 to 3090 F, although having t appearance of porcelain, are essential all crystalline. In all cases the therm conductivity is decreased as the pe centage of beryllium oxide in the c ramic is decreased. Pure beryllium oxide porcelain has a thermal co ductivity approximately equal to alum inum and roughly five times that lead. Additions of magnesium oxid up to 15%, can be made to reduce t maturing temperature of the bodie

Table 5—Thermal Conductivit of Materials

Material	Cal./Sec./ Sq. Cm./ Deg. C/Cm.
Copper	1.0
Aluminum	0.50
Pure Beryllium Oxide	0.42
Beryllium Oxide Porcelain	0.38
Brass	0.26
Iron	0.16
Steel	0.11
Lead	0.083
High Alumina Type Porcelain	0.041
Mullite Type Porcelain	0.007

e thermal conductivities of this type d several other porcelains are com-red with metals in Table 5.

Some of these ceramics possess ex-mely high compressive strength. e molecular composition, 48BeO·-$_2O_3$·ZrO_2 plus 4% MgO, fired at 55 F, had a compressive strength of 5,000 psi.

ordierite-Type Ceramics

The manufacture of ceramics high cordierite was reported as early as 26. Cordierite bodies are character-ed by their excellent thermal endur-ce derived from their relatively low ermal expansion (3.0×10^{-6} or less the range 68 to 1110 F). The for-ation of cordierite in a ceramic body, the ternary system MgO-Al_2O_3-SiO_2, curs to a greater or lesser extent over remarkably wide compositional area hich varies radically with the firing temperature, being largest at about 2370 F. Increase in firing temperature serves to increase individual crystal size until the temperature is reached, at which cordierite dissociates into mullite and a low viscosity melt.

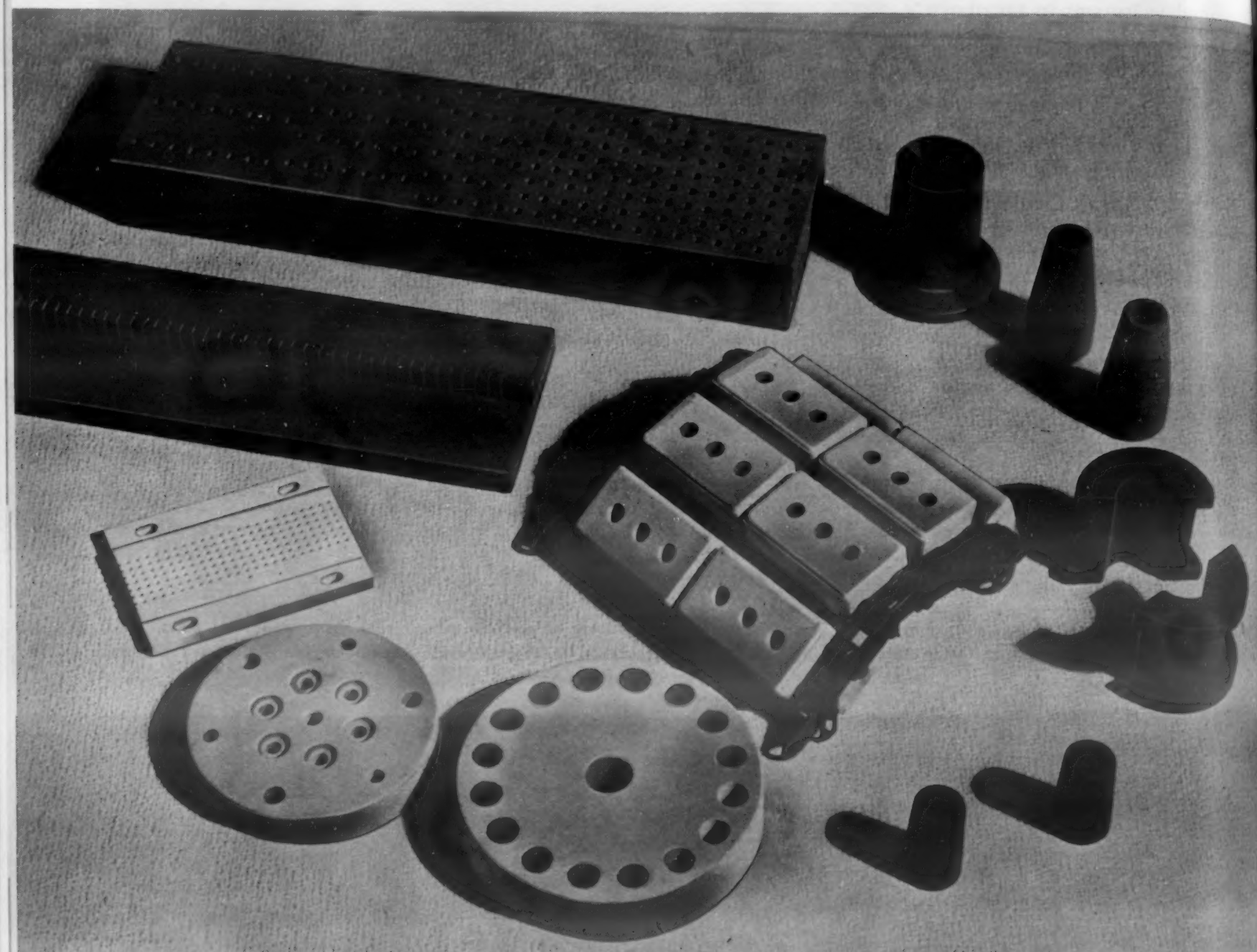
Three types of cordierite bodies have been developed, based on the theoretical composition $2MgO·2Al_2O_3·5SiO_2$.

(1) *Porous bodies* (10 to 15% absorption) containing a high percentage of cordierite synthetically formed from talc, clay and alumina during firing below 680 F. These have relatively little mechanical strength, due to limited crystalline intergrowth and absence of glassy bond. Their use is confined to those applications in which thermal endurance or low thermal expansion is the primary requisite, as radiant elements in gas heating, electric furnace parts, resistor tubes and bases, and rheostat rings. Applications as a ceramic dielectric are limited, due to its porosity. A typical porous cordierite composition is 43 talc, 35 clay and 22% alumina. Fired between cone 12-14 (2390 to 2534 F), the porosity would approximate 12%.

(2) *Low porosity bodies* formed with synthetic cordierite crystals obtained from arc furnace melts of the required composition and depending on recrystallization for the development of mechanical strength and low absorption. These were developed principally for use as refractory brick for furnace lining.

(3) *Vitrified bodies* (absorption less than 0.1%) containing 60% or more synthetically formed cordierite and depending on the addition of feldspars or calcined materials for glass formation below cone 15 (2570 F). Dense cordierite bodies find application in exposed electrical devices which are subjected to thermal variation.

mina-silica ceramic support trays are used by Varian Associates for furnace-brazing of partially assembled Klystron tube and parts. The material remains flat at elevated temperatures, and due to its great resistance to thermal shock, permits rapid heating and cooling cycles. (Courtesy Western Gold & Platinum Works)



One of the many important fields of use of heat resistant ceramics is in induction heating. Pictured here are a group of ceramic pa that serve as fixtures for holding objects during the heating and quenching cycle. For such applications, ceramics with high thermal sho resistance are chosen. (Courtesy American Lava Corp.)

Cordierite bodies do not develop a dense structure, when prepared from the materials usually employed, such as talc, clay and alumina. Compositions so derived and also with the addition of auxiliary fluxes to develop sufficient glass phase are not suitable for commercial production of dense ceramics due to too short a firing range.

A dense cordierite body has been developed recently for dielectric use in electronic applications. An L-3 grade is now being produced commercially on a limited scale. This dense cordierite body is prepared from clays blended with precalcined mixtures of talc, magnesium carbonate and clay. This type body has been further improved dielectrically by the introduction of up to 5% $Ba_2P_2O_8$ to the calcine. A typical calcine (2190 F) is 18.5 talc, 45.8 magnesium carbonate, and 35.7% kaolin. This body contains 35 to 50% of the calcine, the remainder being clay. These dense cordierite ceramics combine the properties of zero absorption, good mechanical strength (12,000 psi.), high dielectric strength (220 v./mil), wide firing range (122 to 140 F) with low thermal expansion (0.88×10^{-6}), and excellent thermal endurance derived from a high cordierite content.

The glazing of cordierite bodies cannot be accomplished with the normal type of glazes, which have a thermal expansion of three or four times that of cordierite and, consequently, craze badly. The porous cordierite ceramic readily reacts with the normal glaze ingredients. A number of solutions to the problem have been proposed, none of which are wholly satisfactory. The addition of alkali flux to the body to provide for self-glazi concurrently narrows the firing ran Some compositions such as fine ground Pyrex glass, certain lithiu aluminum silicates and other compo tions have provided some success.

Zircon Ceramics

Zircon ($ZrSiO_4$) has been used as refractory and has found limited use an ingredient of high temperatu porcelain for many years. Its use spark-plug porcelain has been not elsewhere in this manual. The early zi con porcelains were developed alon the lines of classical electrical porc lain bodies with zircon replacing var ing amounts of the silica content.

In general, zircon imparts strengt low thermal expansion, relatively hig thermal conductivity and thermal e

rance, and high chemical resistivity most ceramic systems. Later, vitri- zircon ceramics have been devel- ed using large amounts of zircon, to ich are added lesser amounts of clays d fluxes of the alkaline earth type, well as other special fluxes. Typical e 10-12 (2300 to 2390 F) zircon rcelain is produced from: 45 to 60 con; 15 to 30 clay; and 15 to 30% aline earth-zirconium silicate. The y content may include ball clays, astic kaolins, and bentonite. The uble silicate fluxes can be calcium-, rium-, strontium-, or magnesium- conium silicates.

All methods used in making steatite electrical porcelain can be employed making zircon porcelain. Zircon is more abrasive and would cause greater wear on dies than does steatite. The thermal endurance of zircon porcelain is superior to steatite and better than normal electrical porcelain. These ceramics are generally L-4 or L-5 in respect to dielectric loss and should find increasing use as ceramic dielectrics. The properties of a typical zircon porcelain are given in Table 3.

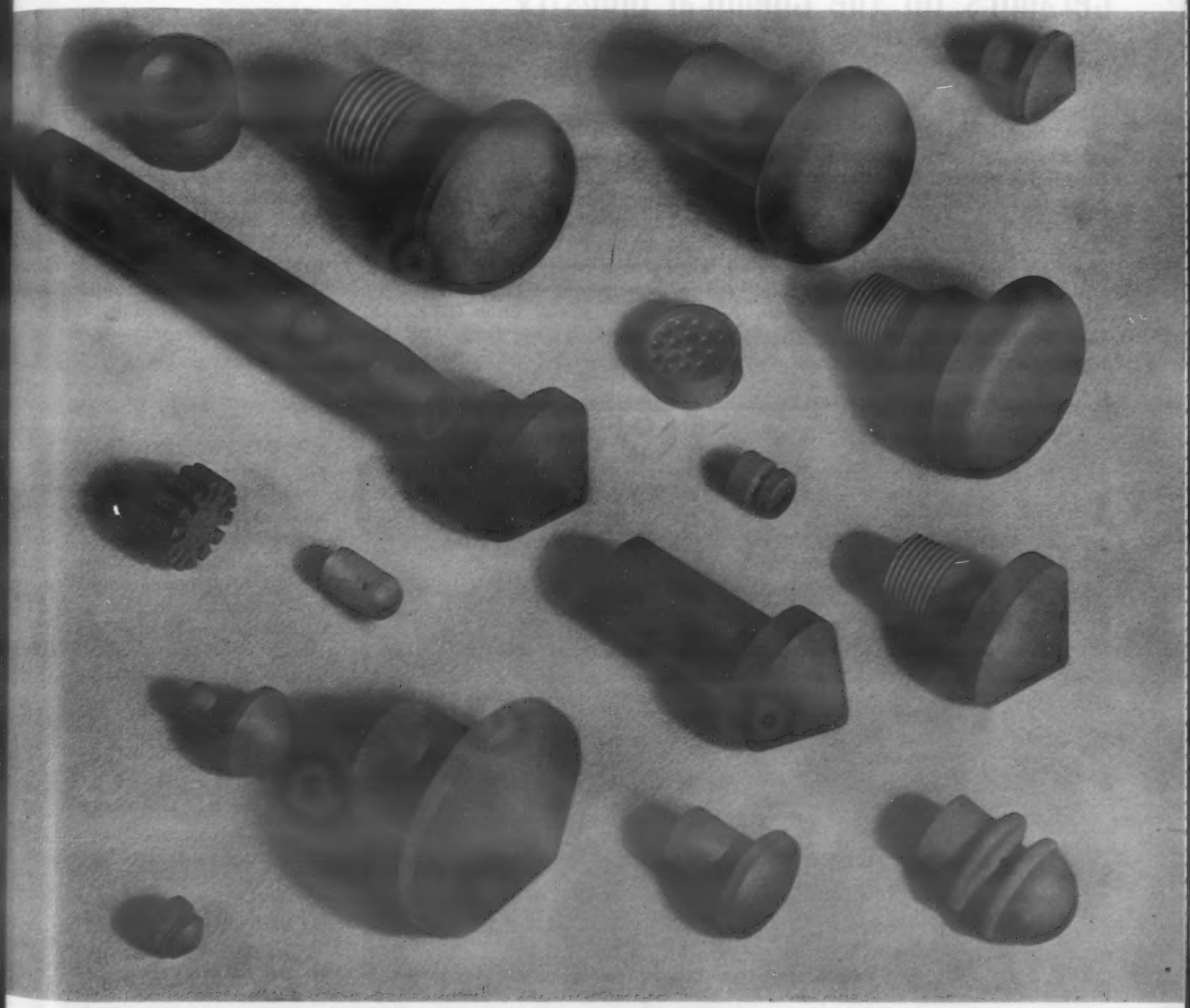
Zircon has also found increasing use in various porous type ceramics for applications requiring high thermal endurance. The so-called Carteret zircon (8% absorption) has been used for a number of years for high temperature metal casting. This material exhibits unusual resistance to thermal shock and is also unique in that it can be machined within final precision tolerances at a preliminary stage in its manufacture.

Zirconia finds use in refractory porcelains and refractory cements. The normally poor heat shock resistance of zirconia is attributed to large and rapid crystal inversions at approximately 1830 F. The latter can be suppressed through formation of solid solutions with, *e.g.*, 8 to 12% calcium oxide or a combination of 6 calcium oxide and 4% magnesium oxide, thus producing "stabilized" zirconia.

Refractory Ceramics

It is not intended to include here a discussion of refractories as required

ramics, because of their refractory properties, are ideally suited for applications involving high temperatures. Their uses in the elevated mperature field include radiant elements and tips in gas heating, electric furnace parts, resistor tubes and refractory porcelain for pyrometer tubes. (Courtesy American Lava Corp.)



for furnaces and kilns, but only certain special ceramics, *e.g.,* refractory porcelain for pyrometer tubes, and porous bodies for radiant heaters.

The classical refractory porcelain body maturing at cone 16 (2642 F) was prepared from: ball clay, 15%; kaolin, 40%; and a refractory constituent, 45%. The latter may be calcined kaolin, alundum, kyanite, sillimanite, or others. This type ceramic has good thermal endurance and has been widely used.

The refractory porcelain for pyrometer tubes must provide for long life of the thermocouple (kiln atmospheric protection) and permit, at the same time, an accurate reading of the temperature. The porcelain must be refractory at the highest temperature encountered, be impervious to the kiln atmosphere, and have the necessary mechanical strength. High clay content bodies are generally used of the Marquardt type, a portion of the clay or alumina as introduced being calcined.

Chemical porcelains referred to later, can be considered as refractory porcelains since they withstand high temperatures and withstand sudden temperature changes as well as corrosive chem cal action.

A number of the refractory ceram widely used are porous bodies. T porous cordierite body has been ext sively used for heating elements, th mocouple insulators and burner ti and for refractory applications, *e.g.,* ditions of materials such as zirc mullite, silicon carbide have been ma to this type body for some uses to crease refractoriness. Porous zirc bodies as already mentioned are high refractory, and are useful where hi thermal endurance is required.

Ceramics for the Chemical Industry

Ceramics used in the chemical and process industries are of two main types: chemical porcelain and chemical stoneware. Average properties for chemical porcelain and stoneware are given in Table 6.

Chemical porcelain and stoneware, like glass, resists all acids except hydrofluoric. Strong, hot caustic alkalis have a slight surface action on this ware. This universal chemical resistance, with above-mentioned exceptions, explains its many uses in the chemical and process industries, *e.g.,* tanks, storage vessels, reactor chambers, condensers, filters, sinks, pipes, cooling coils, pipe fittings, pumps, funnels, ducts, fans, mixers and blungers.

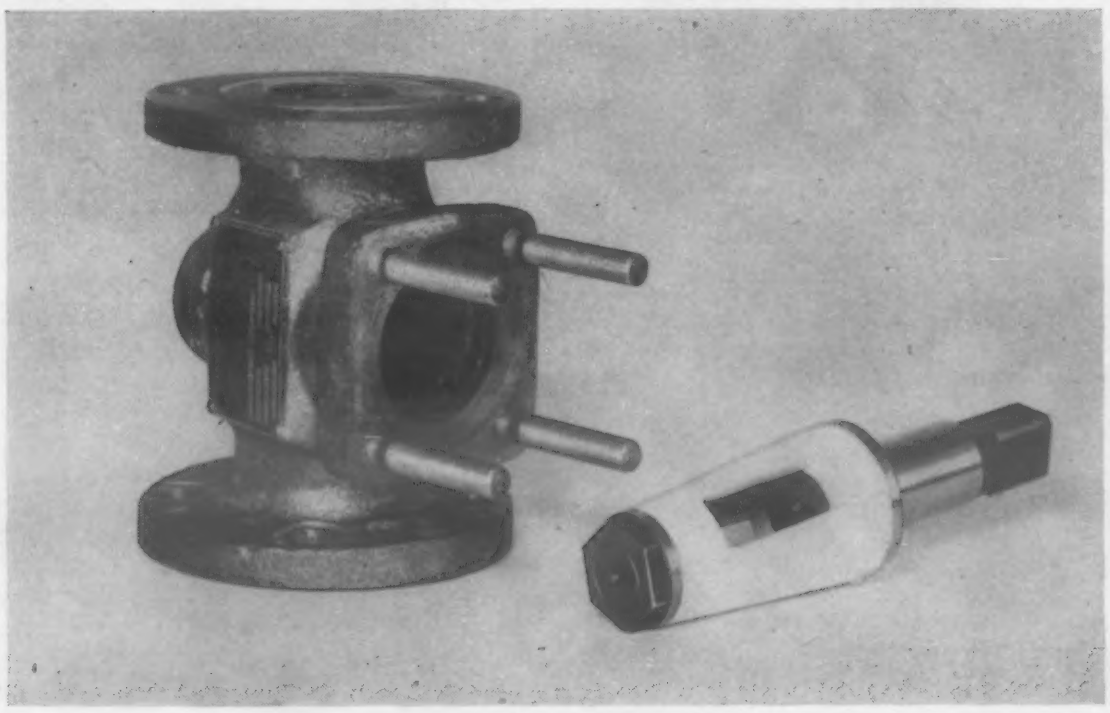
Chemical Porcelain

Chemical porcelain, as used for various laboratory applications, has been made for many years from a conventional type of body, as given in Table 1. The manufacture of this ceramic in this country started on a large scale during World War I. Because of the nature of its service the essential characteristics of chemical porcelain are: (1) resistance to chemical attack; (2) high thermal endurance; (3) high mechanical strength and shock resi ance; (4) constancy in weight af repeated heating and cooling; and (extremely hard and chemically stab glaze, when glazed.

Chemical porcelain is a high d composition generally vitrified at co 14 (2534 F) or higher. The fired c ramic shows high mullite developme and little or no free quartz. Fabric tion is accomplished by convention methods — jiggering, casting, and combination of these operations. T glaze is a hard porcelain type genera applied on the ware in the dry sta and single-fired. Much of the succ attained in the production of chemi porcelain is dependent upon close co trol of raw materials and manufactu ing operations.

Chemical porcelain is preferred chemical stoneware except in certa applications where a white, hard bo is desired. Except for large shap equipment can be made of either c ramic.

An interesting application of technical ceramics is this wear resistant valve insert for pipelines handling corrosive liquids. (Courtesy Norton Co.)



Chemical Stoneware

Chemical stoneware is a vitrifi product, one of the oldest of ceram wares, which more generally has be prepared from mixtures of the follow ing range of composition: 30 to 70 clay, generally a blend of clays; 5 25% feldspar; and 30 to 60% silic Special compositions have been em ployed for certain applications, for e ample, where greater thermal endu ance is needed or for certain speci operations.

Stoneware can be classified into two es: a dense vitrified body for use th corrosive liquids, and a less dense dy for use in contact with corrosive nes. The materials and processes in- lved in the manufacture of these ns provide for relatively inexpensive amics. The ceramic is adaptable to cision finishing. Large parts can be und to a tolerance of 0.0001 in.

The usefulness of chemical stone- re equipment has been extended by ering the exterior surface with rmanite" resin and woven glass ric. This armoring gives physical tection to a piece of stoneware ipment which is superior to metal cause it is corrosion resisting. Pipe d fittings, valves, towers and con- iners have been armored in this hion. Permanite pipe is completely istant throughout to all non-oxidiz- g acids, alkalies and organic solvents. einforced with a chemical glass fabric, is light in weight, yet unusually ong. For hydrofluoric acid service it y be reinforced with nylon or Or- n acrylic fabric. It is easy to cut and emble and can be used with either in-end wrapped or cemented-on- tal flanged joints. The same fittings d for fumes and gases can be used liquids.

Table 6—Physical Properties of Typical Chemical Stoneware and Chemical Porcelain

	Chemical Stoneware	Chemical Porcelain
Specific Gravity	2.2	2.5
Flexural Strength, Psi.	6,500	14,000
Tensile Strength, Psi.	2,500	6,000
Compressive Strength, Psi.	80,000	100,000
Modulus of Elasticity x 10^{-6}, Psi.	10	15
Coefficient of Thermal Expansion x 10^{6} (68 to 1110 F)	5	4

Special Types

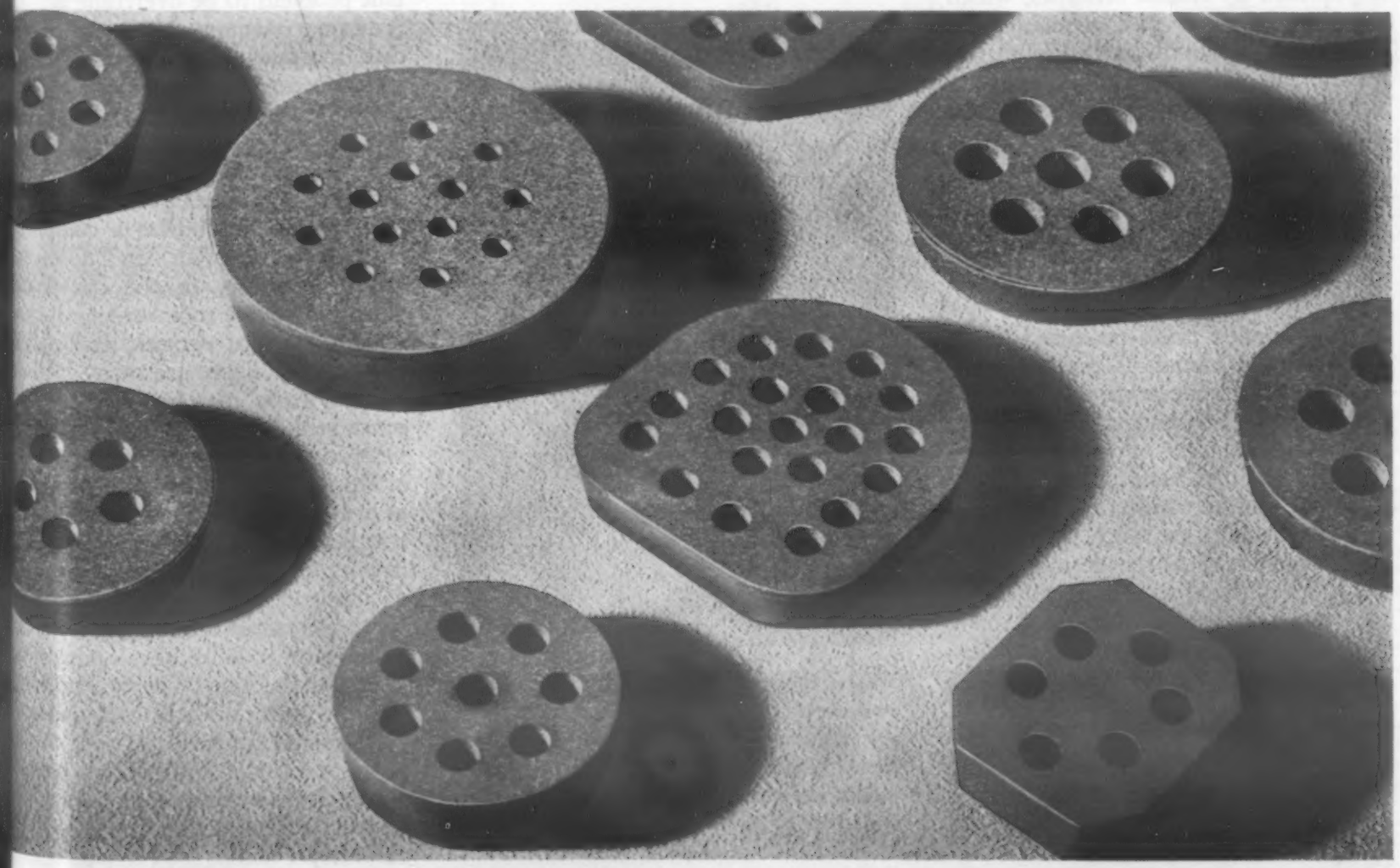
As in other fields, the chemical industries have demanded ceramics for some applications which must be outstanding in one or more properties. Certain non-plastic materials, *e.g.,* zircon, corundum, magnesia, silicon carbide and crystalline mullite, have been added to these ceramics to obtain desirable properties.

The field of porous bodies covers a wide range, with each use presenting new requirements. As diaphragms in the electrochemical field, they are usually very high in non-plastics, which may be corundum, mullite, silica, or artificial grog. Here permeability, electrical resistance and strength are most important.

Porous bodies used for filters of liquid or gases can be soft fired high clay bodies with relatively large pores often obtained from burning out of organic material purposely added during body preparation.

Recent developments have brought about increasing use of glass in chemical equipment. Glass piping, of greatly improved strength and facility for installation, is finding wide application in the chemical industries. Glass columns and unit heat exchangers are other examples of interesting new applications. Improved design of many details of glass-lined steel equipment have provided for apparatus which will meet operating conditions of higher pressure and temperature.

e universal chemical resistance of ceramics is the main reason for their wide use for such applications as tanks, reactor chambers, ndensers, filters, piping, pumps and mixers. These porous strainer cores illustrate one of the many uses of ceramic bodies in the chemical and process industries. (Courtesy American Lava Corp.)



Special Purpose Ceramics

Titania Ceramics

Titanium compounds have been used extensively in a wide variety of ceramic products. The oxide, as a glaze component, provides opacity, improves acid resistance, and for some glazes reduces thermal expansion. Acid-resistant and superopaque enamels have been developed with this material. Titania ceramics have been used to some extent, as are porcelain ceramics for thread guides in the textile industry, for parts such as: eyelets, sleeves, winder guides, and shuttle pins.

Without doubt the present most important use of titania (rutile) and titanate bodies results from the high dielectric constant characteristics of these materials. Some dielectric constant values of these materials at ordinary temperatures are:

Material	*K Value of Ceramic*
Magnesium titanate	13-17
Heavy grade TiO_2	95-105
Calcium titanate	150-175
Strontium titanate	225-250
Barium titanate	1200-1500
Barium-strontium titanate	10,000

A wide choice of available properties is provided by titania ceramics, which accounts for their general acceptance. A few of the applications might be mentioned, such as their use in resistors, capacitors of high capacity and small size, trimmers, compensating components, wave guides, photoelectric cells, and substitutes for mica capacitors.

Mica Ceramics

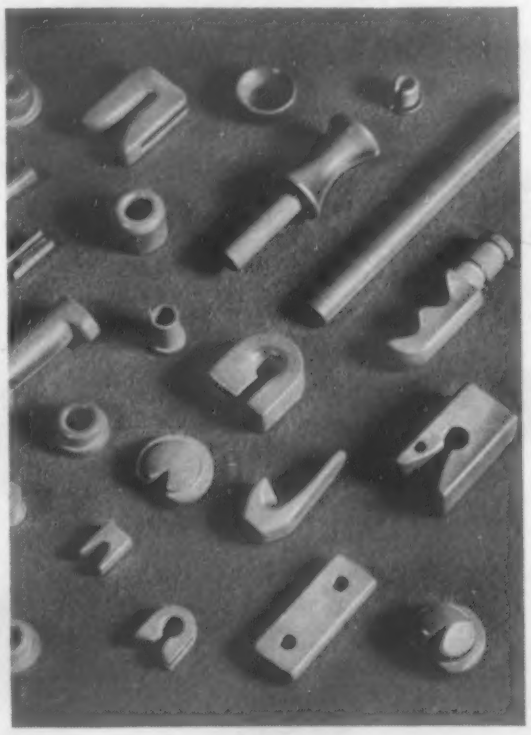
Glass-bonded mica, produced under various trade names, is essentially an aggregation of fine mica particles embedded in a glass matrix. A commonly used ratio consists of 60% mica to 40% glass, the latter generally lead borate or lead boro-silicate. It is formed by compression molding, pressing a preformed blank to the desired shape, by transfer molding or by injection molding. This material has found many applications as panels, shields, supports, spacers, and numerous insulating parts.

The extensive mica synthesis program under way has produced a by-product which possibly may find application — a polycrystalline material formed in the solid state (several hundred degrees below the fusion point) by pressing the disintegrated synthetic fluorine phlogopite at 2190 F using a pressure of 700 psi. This material reportedly can be readily machined with small loss. Attempts have also been made to use pure mica scrap in producing sheets; some success has been claimed.

High Temperature Ceramics for Mechanical Parts

One of the important advances in recent years has been the development of high strength ceramic materials for high temperature service, such as in jet engines, gas turbines and rockets. This development was to be expected, since ceramics possess a number of inherent advantages over metals. Their melting points are, in general, much higher. Their bulk density, a property of great value in rotating disks and blades, is considerably lower. And they are very hard and chemically inert, therefore more resistant to erosion and corrosion and longer lived.

The development work on high strength refractories before World War II was rather limited. The best materials in use industrially were the mullite and high aluminum oxide bodies. These were used for spark plugs, furnace bricks, glass melting tanks, and pyrometer tubes.



Titania ceramics are useful for many special purpose applications. They have found wide use, for example, in the textile industry for thread guides such as eyelets, sleeves, winder guides and shuttle pins. Here shown are some typical guide parts. (Courtesy American Lava Corp.)

The most important high temperature ceramics at present are compositions that contain combinations of refractory oxides of the following elements: beryllium (BeO), aluminum (Al_2O_3), zirconium (ZrO_2), thorium (ThO_2), magnesium (MgO), and calcium (CaO). Typical bodies developed by the Bureau of Standards contain large percentages of beryllium oxide or zirconium oxide with smaller quantities of the oxides of magnesium, calcium, silicon, titanium or boron. Older refractory bodies contained large proportions of mullite ($3Al_2O_3 \cdot 2SiO_2$). These refractory oxides are generally found in natural ores, such as silicates of aluminum (sillimanite, kyonite and andalusite), and require varying degrees of concentration and refining.

One of the most difficult problems to overcome in the manufacture of ceramic turbine blades is the fabrication of the thin twisted airfoil shapes necessary for high efficiency. Another important problem to be overcome is that of fastening a ceramic blade to a metal disk. Inasmuch as the ceramic materials exhibit no plastic deformation at room temperature, it is impossible to press a ceramic blade root into a slot in the disk. In addition, from the results of recent tests it appears to be impractical to fabricate and utilize a complicated blade fastening with small fillets, such as are necessary in the conventional "fir tree" type of root.

The study of ceramic materials has just started. There are many facts concerning basic material properties that must still be determined. Future developments will follow along the lines of developing new materials with greater heat shock resistance and strength at temperatures in excess of 2000 F, and developing new manufacturing techniques and methods for mechanically joining ceramics and metals or ceramics and ceramics. With developments such as these, the use of high temperature ceramic materials will continue to expand in the future.

[For additional information on high temperature ceramics, see MATERIALS & METHODS, Jan. 1948, p. 65—*The Editors.*]

Materials Engineering File Facts

NUMBER 197
September, 1950

MATERIALS DATA SHEET

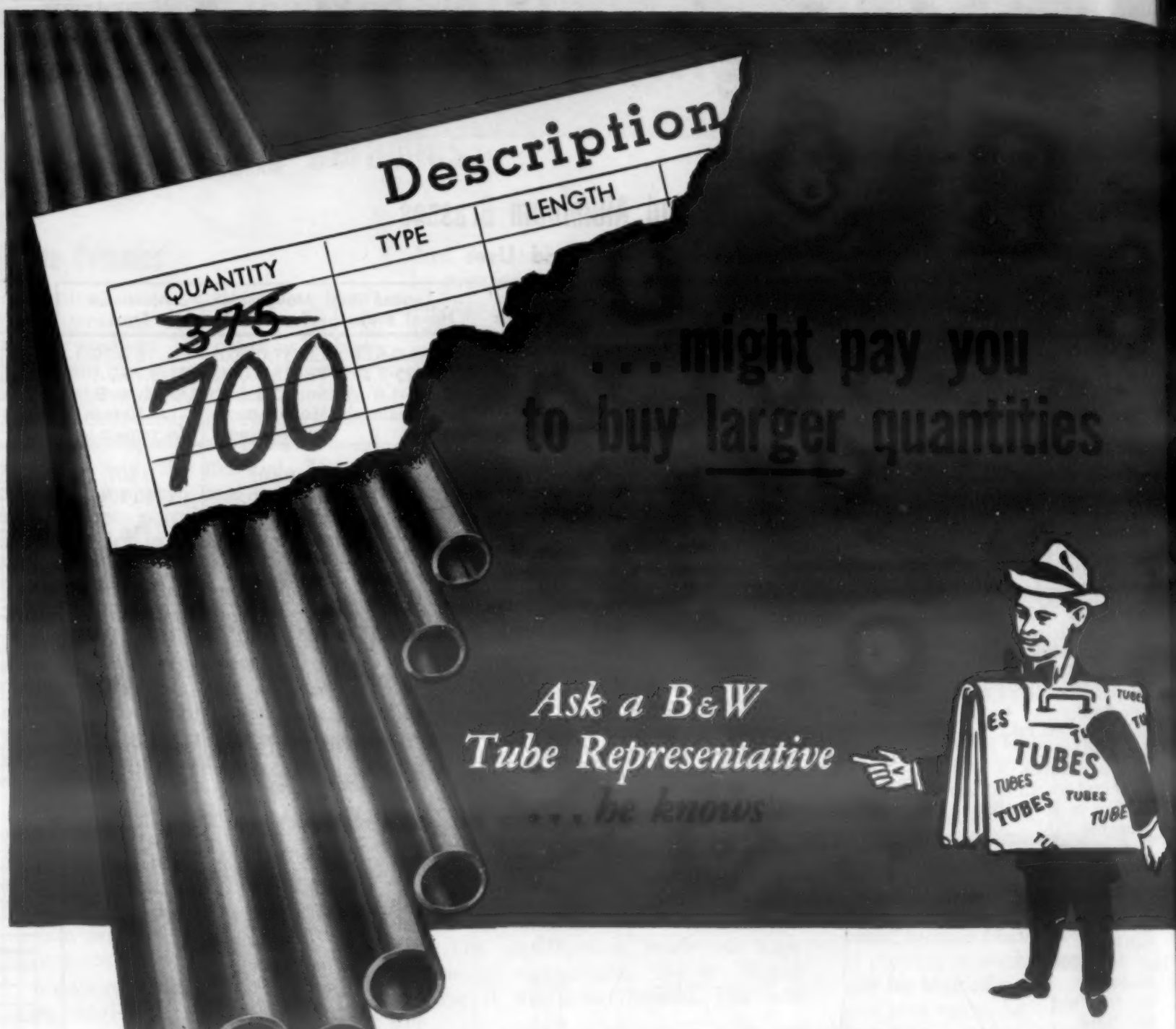
Wrought Tin and Aluminum Brasses

Typical Properties and Uses

TYPE	Admiralty	Naval Brass	Leaded Naval Brass	Manganese Bronze (A)	Aluminum Brass
COMPOSITION	Cu, 70.0-73.0 Sn, 0.9-1.2 As, Sb, or P ....0.10 max. Zn, remainder	Cu, 59.0-62.0 Sn, 0.5-1.0 Zn, remainder	Cu, 59.0-62.0 Pb, 1.25-2.25 Sn, 0.5-1.0 Zn, remainder	Cu, 57.0-60.0 Fe, 0.8-2.0 Sn, 0.5-1.5 Mn, 0.5 max. Zn, remainder	Cu, 76.0-79.0 Al, 1.75-2.5 As, Sb, or P ....0.10 max. Zn, remainder
PHYSICAL PROPERTIES					
Density, Lb./Cu. In.	0.308	0.304	0.305	0.302	0.301
Melting Range, F	1650-1720	1630-1650	1630-1650	1590-1630	1710-1780
Thermal Cond., Btu./Hr./Sq. Ft./Ft./deg. F, @ 68 F	64	67	67	61	58
Coeff. of Exp. per deg. F (68-572 F)	11.2×10^{-6}	11.8×10^{-6}	11.8×10^{-6}	11.8×10^{-6}	10.3×10^{-6}
Spec. Ht., Btu./Lb./deg. F @ 68 F	0.09	0.09	0.09	0.09	0.09
Elec. Res., Microhm-Cm. @ 68 F (Annealed)	6.9	6.6	6.6	7.2	7.5
[1]MECHANICAL PROPERTIES					
Mod. of Elasticity in Tension, Psi.	16.0×10^6	15.0×10^6	15.0×10^6	15.0×10^6	16.0×10^6
Tensile Str., 1000 Psi.:					
[2]Annealed	53.0	57.0	57.0	65.0	60.0
Quarter-Hard	—	69.0	69.0	77.0	—
Half-Hard	—	75.0	75.0	84.0	—
[3]Yield Str., 1000 Psi.:					
Annealed	22.0	25.0	25.0	30.0	27.0
Quarter-Hard	—	46.0	46.0	45.0	—
Half-Hard	—	53.0	53.0	60.0	—
Elongation in 2 In., %:					
Annealed	65	47	40	33	55
Quarter-Hard	—	27	20	23	—
Half-Hard	—	20	15	19	—
Hardness, Rockwell:					
Annealed	75F	55B	55B	65B	77F
Quarter-Hard	—	78B	78B	83B	—
Half-Hard	—	82B	82B	90 B	—
Shear Str., 1000 Psi.:					
Annealed	—	40.0	36.0	42.0	—
Quarter-Hard	—	43.0	39.0	47.0	—
Half-Hard	—	44.0	40.0	48.0	—
FABRICATING PROPERTIES:					
Capacity for Being Cold Worked	Excellent	Fair	Poor	Poor	Excellent
Capacity for Being Hot Worked	Fair	Excellent	Good	Excellent	Fair
Hot Working Range, F	1200-1450	1200-1500	1200-1400	1150-1450	1400-1600
Annealing Temp., F	800-1100	800-1100	800-1100	800-1100	800-1100
Machinability Index (Free Cutting Brass=100)	30	30	70	30	30
Joining Characteristics:					
Soft Soldering	Excellent	Excellent	Excellent	Excellent	Good
Silver Alloy Brazing	Good	Good	Good	Good	Good
Oxyacetylene Welding	Good	Good	Fair	Good	Good
Carbon Arc Welding	Fair	Fair	Poor	Fair	Good
Resistance Welding	Fair	Fair	Poor	Good	Good
Common Fabrication Processes:	Forming and bending, machining.	Blanking, drawing, forming and bending, heading and upsetting, hot forging and pressing, hot heading and upsetting, shearing.	Hot forging and pressing, machining.	Hot forging and pressing, hot heading and upsetting.	Forming and bending.
CORROSION RESISTANCE	Good resistance to industrial, rural and marine atmospheres; petroleum products, alcohols, dry gases and sea water. Fairly good resistance to weak bases. Resistance to some weak bases and weak organic acids but generally poor resistance to most acids and strong bases. Also, poor resistance to solutions of cyanides and ammonium compounds. Resistant to dezincification, with the addition of arsenic, antimony and phosphorus in Admiralty and Aluminum Brass greatly increasing this resistance.				
COMMON FORMS	Plate, wire, tube.	Rolled strip, rolled and drawn bar, plate, rod, tube, shapes.	Drawn bar, rod, shapes.	Rod, shapes.	Tube.
TYPICAL USES	Condenser, evaporator and heat exchanger tubes, condenser tube plates, distiller tubes, ferrules.	Aircraft turnbuckle barrels, balls, bolts, marine hardware, nuts, propeller shafts, rivets, structural uses, valve stems, condenser plates, welding rods.	Marine hardware, screw machine products, valve stems.	Clutch disks, pump rods, shafting, balls, valve stems, and bodies, welding rods.	Condenser, evaporator and heat exchanger tubes, distiller tubes, ferrules.

[1]*Mechanical properties are based on 1-in. section dia. Values for Admiralty and Aluminum Brass apply to tube; other values apply to rod.*
[2]*These annealed properties represent those of softest tempers used commercially. Annealed tempers must be specified by grain size.*
[3]*Yield strength for 0.5% extension under load.*

Prepared with the assistance of the Copper & Brass Research Assn.



You may be paying more than you should for your mechanical or pressure tubing . . . or both . . . simply because of your purchasing procedure.

FOR EXAMPLE: Ordering larger quantities at *longer* intervals may result in lower unit cost because the savings in manufacture, handling, and shipment of such orders are passed on to the customer. Further, you simplify paper work and provide an inventory against your unscheduled production demands . . . at a saving.

Because B&W Tube Representatives are factory trained in "tube technics", they are able to help you uncover new economies in the purchase and uses of B&W Mechanical and Pressure Tubing.

B&W SEAMLESS and WELDED TUBES

THE BABCOCK & WILCOX TUBE COMPANY

General Offices: Beaver Falls, Pa.

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TA-1564

Materials Engineering File Facts

NUMBER 198
September, 1950

MATERIALS DATA SHEET

Nickel-Chromium-Molybdenum Steels

AISI TYPE	4317	4320	4337	4340
COMPOSITION	C, 0.15-0.20 Mn, 0.45-0.65 Ni, 1.65-2.00 Cr, 0.40-0.60 Mo, 0.20-0.30	C, 0.17-0.22 Mn, 0.45-0.65 Ni, 1.62-2.00 Cr, 0.40-0.60 Mo, 0.20-0.30	C, 0.35-0.40 Mn, 0.60-0.80 Ni, 1.65-2.00 Cr, 0.70-0.90 Mo, 0.20-0.30	C, 0.38-0.43 Mn, 0.60-0.80 Ni, 1.65-2.00 Cr, 0.70-0.90 Mo, 0.20-0.30
PHYSICAL PROPERTIES				
Density, Lb./Cu. In.	0.283	0.283	0.283	0.283
Melting Point (Approx.), F	2750	2750	2740	2740
Thermal Cond., Btu./Hr./Sq. Ft./In./Deg. F, @ 120 F	260	260	260	260
Coeff. of Exp. per Deg. F:				
0 to 200 F	6.3×10^{-6}	6.3×10^{-6}	6.3×10^{-6}	6.3×10^{-6}
0 to 1200 F	8.1×10^{-6}	8.1×10^{-6}	8.1×10^{-6}	8.1×10^{-6}
Spec. Ht., Btu./Lb./Deg. F:	0.107	0.107	0.107	0.107
Elect. Res., Microhm-Cm.:				
at 120 F	30	30	30	30
at 570 F	48	48	48	48
Magnetic Properties	Magnetic	Magnetic	Magnetic	Magnetic
MECHANICAL PROPERTIES				
Mod. of Elasticity in Tension, Psi.	$29\text{-}30 \times 10^6$	$29\text{-}30 \times 10^6$	$29\text{-}30 \times 10^6$	$29\text{-}30 \times 10^6$
Tensile Str., 1000 Psi.:				
As Rolled	122.0	134.0	180.0	192.0
Annealed	95.0	98.0	115.0	119.0
Hard. & Temp. @ 800 F[1]	160.0[2]	180.0[2]	210.0	220.0
Hard. & Temp. @ 1200 F[1]			140.0	150.0
Yield Str., 1000 Psi.:				
As Rolled	99.0	102.0	141.0	147.0
Annealed	77.0	89.0	96.0	99.0
Hard. & Temp. @ 800 F[1]	130.0[2]	154.0[2]	190.0	200.0
Hard. & Temp. @ 1200 F[1]			120.0	130.0
Elongation in 2 in., %:				
As Rolled	19	17	11	9
Annealed	25	23	19	17
Hard. & Temp. @ 800 F[1]	17[2]	15[2]	14	12
Hard. & Temp. @ 1200 F[1]			21	19
Reduction of Area, %:				
As Rolled	47	43	21	19
Annealed	54	52	45	43
Hard. & Temp. @ 800 F[1]	57[2]	50[2]	50	48
Hard. & Temp. @ 1200 F[1]			59	57
Hardness, Bhn.:				
As Rolled	250	265	365	380
Annealed	185	195	230	240
Hard. & Temp. @ 800 F[1]	320[2]	360[2]	435	445
Hard. & Temp. @ 1200 F[1]			300	310
Impact Str., Izod., Ft.-Lb.:				
Hard. & Temp. @ 800 F[1]	40[2]	32[2]	18	16
Hard. & Temp. @ 1200 F[1]			75	73
FABRICATING PROPERTIES				
Annealing Temp., F	1550-1600	1550-1600	1550-1600	1550-1600
Hardening Temp., F	1525-1575	1525-1575	1475-1550	1475-1550
Max. Hot Working Temp., F	2300	2300	2300	2300
Machinability Index (AISI B1112 = 100)	55	51	51	51
Weldability:	All grades are readily weldable by oxyacetylene, inert arc and electrical resistance methods. Preheating desirable for AISI 4337 and 4340.			
CORROSION RESISTANCE	These steels have better corrosion resistance than the plain carbon steels.			
AVAILABLE FORMS	These steels are usually supplied as bars, forgings, tubing and billets, but can be obtained in all steel mill forms.			
USES	Heavy-duty carburized parts such as gears, bearing races.		Heavy-duty, high-strength applications, particularly in sections over about 1½ in. thick. Gears, aircraft tubing, shafts, heavy forgings, churn drills, etc.	

NOTES: [1] *Properties after heat treatment are based upon an oil quench and 1-in. round bars.*
[2] *These are core properties of pseudo-carburized 1-in. bars, tempered at 300 F.*

Prepared with the assistance of the International Nickel Co.

NEW...

16-Page Booklet on PLEXIGLAS Molding Powders

Send for your copy

Specially prepared for plastics molders, this file-size booklet summarizes the up-to-date information you need on acrylic molding powders.

Its 16 concise, readable pages—fully illustrated with photographs and drawings—include a complete 2-page tabular digest of PLEXIGLAS physical properties, as well as helpful pointers on the application of specific PLEXIGLAS Molding Powders to various types of jobs.

For easier, more economical molding of industrial and automotive parts, signs and sign letters, household decorations and accessories—it will pay you to have on file this handy guide and reference booklet. A request on your business letterhead will bring you your free copy.

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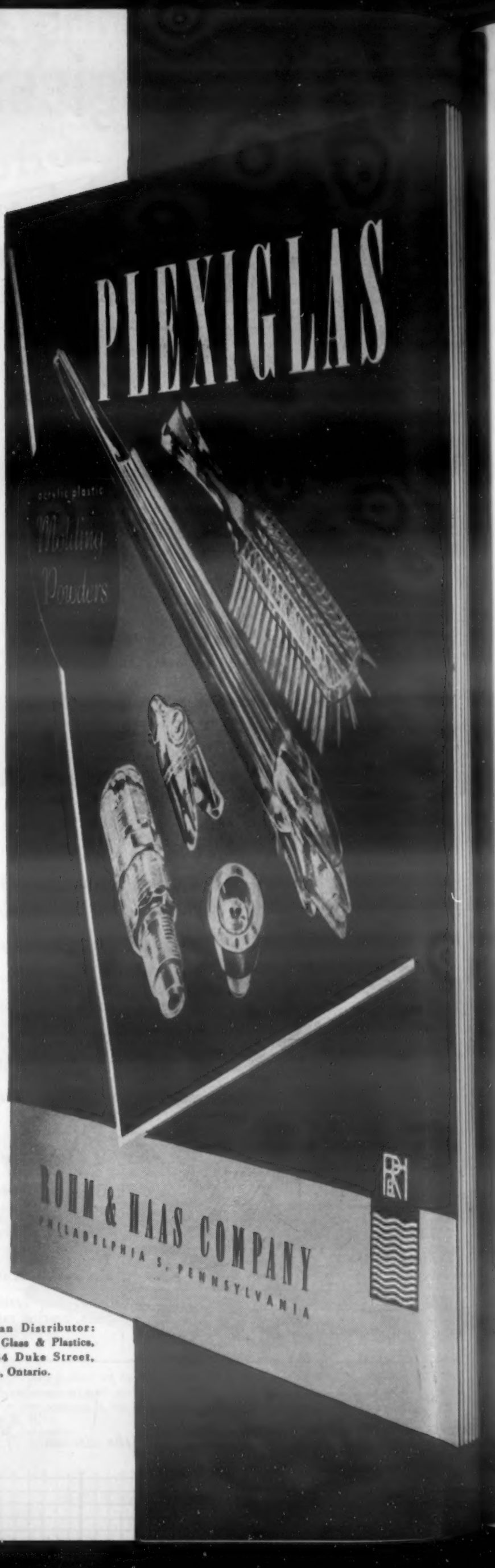

CHEMICALS FOR INDUSTRY

ROHM & HAAS COMPANY

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Representatives in principal foreign countries

Canadian Distributor:
Crystal Glass & Plastics, Ltd., 54 Duke Street, Toronto, Ontario.

New Materials and Equipment

Materials

Glass-Fiber Tube

Designed as a replacement for steel and other critical war metals in many commercial applications, a new glass-fiber tube and pipe material is now being manufactured by *United States Plywood Corp.*, 55 West 44 St., New York 18.

Glasweld, a glass-fiber tube and pipe material, is designed as a replacement for steel and other critical war metals.

This new product, known as Glasweld, is claimed to have the strength of steel and to be rust and corrosion proof. Glass fibers, in the form of cloth, mat or tape, are bonded with resins in the production of Glasweld, making it impervious to extreme heat, chemical action and sledgehammer blows, according to the manufacturer.

Glasweld is already being used by the U. S. Army, and in structural and electrical fields, where its light weight, good electrical properties and high strength factor have proved advantageous.

Glass Fiber Insulation

A new braided fiberglas tubing and sleeving claimed to have superior physical and dielectric properties at a price comparable to ordinary cotton or rayon-base insulations has been announced by *Bently, Harris Mfg. Co.*, Conshohocken, Pa.

Known as BH 649, the new product is said to stand up under the roughest knotting and twisting without sign of insulation breakdown. It will not support combustion and cuts clean, making wire threading easy. BH 649 will withstand temperatures of 450 F for 60 min. and 220 F for 96 hr. with practically no physical change or loss of dielectric strength.

Expected uses range from radio and television sets to mechanical counters and complicated switchboards.

CONTENTS

	PAGE
Materials	89
Parts & Forms	90
Coatings & Finishes	94
Cleaning & Finishing	98
Welding & Joining	104
Forming & Machining	106
Testing & Control	114
Heating, Heat Treatment	126
General	132

Hard Facing Electrode

A hard facing electrode which deposits a bead having a hardness of Rockwell C 63-68 has been announced by *Eutectic Welding Alloys Corp.*, 40 Worth St., New York 13.

Named EutecTrode 10, the electrode is claimed to be well suited to the hard-facing of such items as roller cams, rolling dies and pulverizing rollers. Furthermore, it is claimed that EutecTrode 10 will not become soft and lose its strength at elevated temperatures and that its red hardness is above that of most conventional alloys.

Plastic Roofing

New translucent, fiber glass-reinforced plastic Corrulux sheets for industrial roofing are being distributed by *Levinson Steel Sales Co.*, 33 Pride St., Pittsburgh, Pa.

Designed to provide more adequate and economical lighting in warehouses and plants, these plastic sheets can be installed like any other roofing, requiring no extra labor or equipment. It can be nailed, bolted or strapped without using special framing or flashing, according to the manufacturer. Corrulux is said to be water resistant and unbreakable, and to provide cool storage and working conditions.

New Electrical Insulation

Development of a new electrical insulation which is reported to last ten times as long as conventional insulations under severe electrical stress has been announced by *Westinghouse Electric Corp.*, 306 Fourth Ave., Pittsburgh 30.

Called Thermalastic, the new insulation consists of mica flakes embedded in tough, heat-resistant synthetic resin which possesses

New Materials and Equipment
(CONTINUED)

sufficient strength at operating temperatures to expand and contract with the coils of large electric generators.

Under heat, Thermalastic is said to expand only one-fourth as much as asphalt-bonded insulation. At 212 F, it has 30 times the tensile strength of conventional insulations. Other advantages claimed by the manufacturer are that Thermalastic's insulation losses are 70% less and its electrical strength 20% greater than those of ordinary electric insulators.

Plastic Electrical Insulation

Development of a plastic electrical insulation that will not support combustion has been revealed by *E. I. du Pont de Nemours and Co. (Inc.)*, of Wilmington, Del.

Known as Rulan flame-retardant plastic, its electrical properties approach those of polythene, one of the best insulating materials known. But, while flammability has been a characteristic disadvantage of plastics with good electrical properties, tests with Rulan are said to show that it will not burn after the flame has been removed. In addition, these tests indicate that "Rulan" will not drip when molten, an important advantage because of the possibility of hot plastic drippings starting fires.

Rulan has a power factor, over a wide range of frequencies, of 0.002, compared with 0.0002 for polythene and a dielectric constant of 2.7, compared with that of less than 2.5 for polythene.

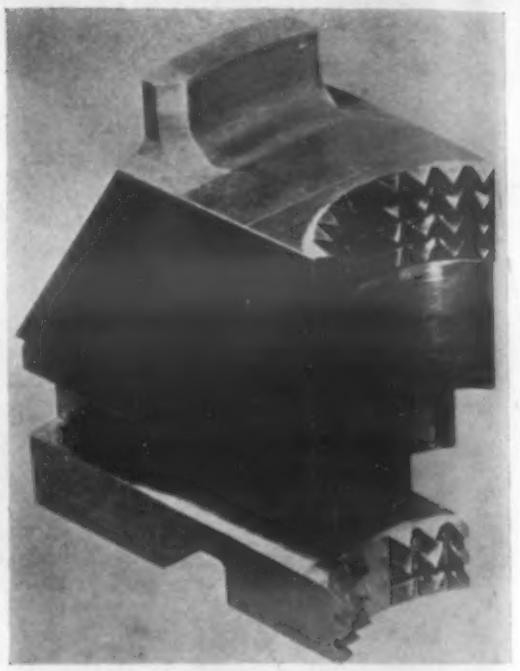
Larger Seamless Tube

An increase in the size range of its seamless steel tubing has been announced by the *Babcock & Wilcox Tube Co.*, Beaver Falls, Pa. Seamless hot finished tubing can now be furnished in outside diameters up to 9⅝ in., while seamless cold drawn tubing is available in outside diameters up to 8⅞ in.

Cast Hard Facing Inserts

Development of Colmonoy hard facing alloy cast inserts for chuck jaws has been announced by *Diamonds and Tools, Inc.*, 19345 John R. St., Detroit 3, Mich.

Available separately or as a complete jaw with the Colmonoy inserts ground in place, these inserts are said to give longer service with greater accuracy than tool steel jaws.



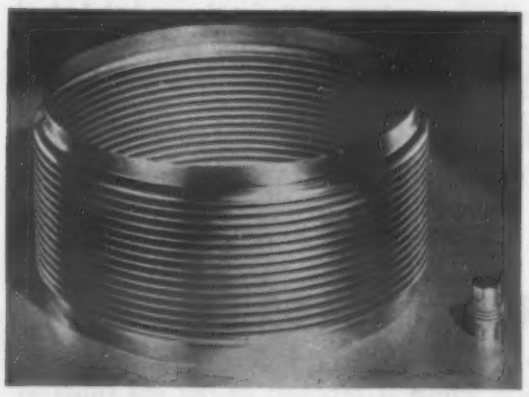
Colmonoy hard facing alloy cast inserts give this chuck jaw longer life and greater accuracy.

Furthermore, when the inserts become worn, new ones can be set into place by silver soldering after the jaw has been heated and the old ones removed. Heat treating of the jaws, of course, is eliminated by the use of the Colmonoy inserts.

Parts & Forms

Stainless Steel Bellows

Stainless steel bellows said to be especially suitable for applications of control devices



A complete range of sizes is available in Chicago Metal Hose stainless steel bellows.

and instrumentation, are now available in a complete range of sizes from *Chicago Metal Hose Corp.*, Maywood, Ill.

Designed to overcome problems of pressure, high and low temperatures and corrosion, they are used for regulators, valves, steam traps, shaft seals, expansion connections and flexible connectors in cases of misalignment.

Insulated Grommet

Automotive Rubber Co., Inc., 8601 Epworth Blvd., Detroit 4, has announced a newly-designed, metal-formed grommet completely covered with rubber. The grommet, called the ARCO Sta-Put Series 3120, is designed for insulating blanked holes in metal to prevent cutting, chafing, shorting and rattling of wires, cables, conduit and tubing which pass through the holes.

Principal advantages of the Sta-Put grommet are said to be its easy and rapid installment. In addition, it is claimed that it will not loosen or pull out, exposing the sharp edges of the blanked metal.

Brazed Metal Strip

Nonferrous metal strip, laminated on one or both sides with a layer of silver brazing alloy, is now available from the *Rolled Plate Div.* of the *American Silver Co., Inc.*, Flushing, N. Y.

Manufactured by a process called Brazeclad, in which silver brazing alloy is diffused into the parent metal at the supplier's plant, this metal strip is claimed to eliminate the necessity of using rings, washers, pre-formed

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HIGH-TENSILE STEEL

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NAX GREAT IMPACT TOUGHNESS

NAX HIGH STRENGTH

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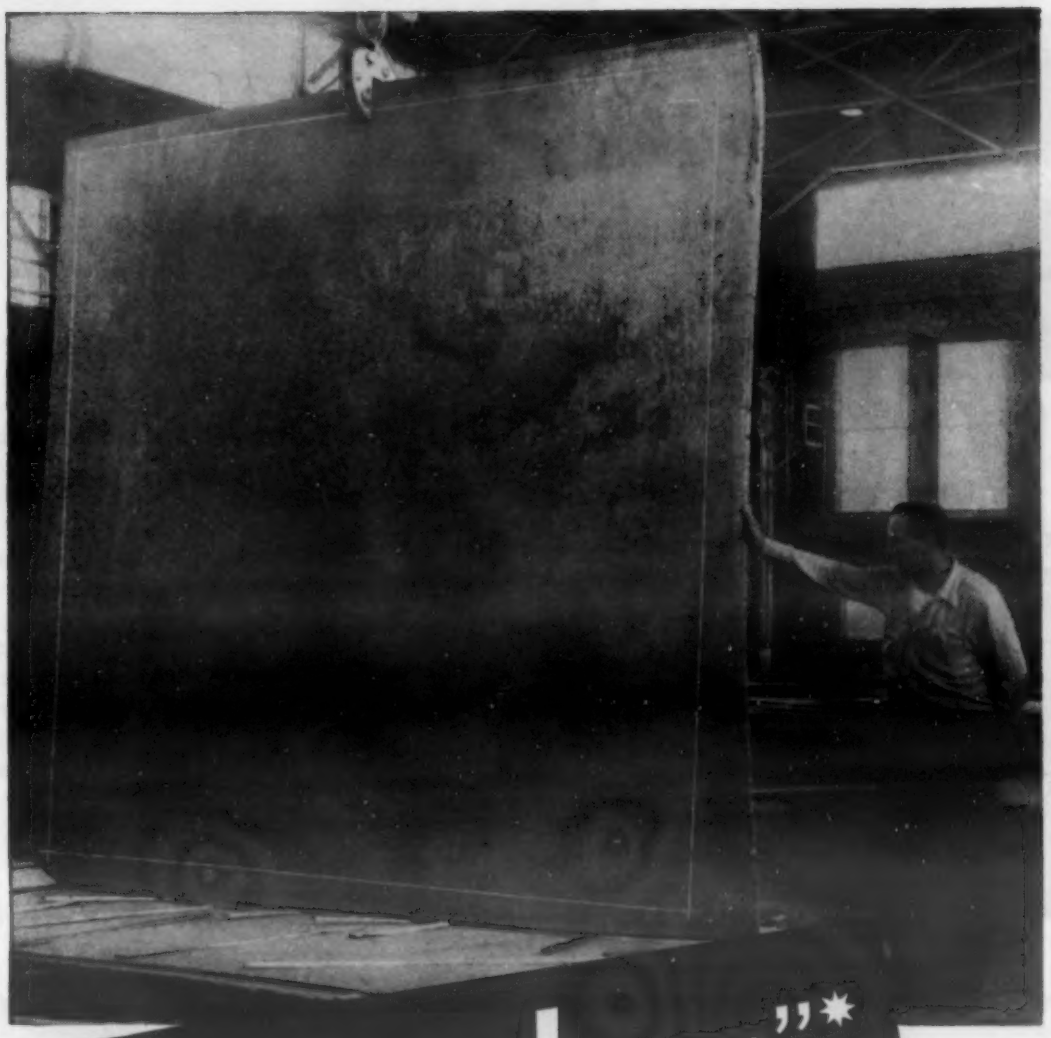
N-A-X ALLOY DIVISION • ECORSE, DETROIT 29, MICH. • UNIT OF NATIONAL STEEL CORPORATION



✸ Type 347 2¼" x 123" x 123" Pattern size weight of plate 13,000 pounds.

"Medium large"✸ STAINLESS STEEL PLATE

by G. O. CARLSON

Many orders such as the above can be filled without depleting Carlson's vast stocks — where stainless steel plates of chemical industry quality are on hand at all times to fill your requirements for plates in any size and in all analyses.

This "medium-large" rectangle, Type 347, 2¼" x 123" x 123" was pattern cut to customer specifications and a 13,000 pound stainless steel plate was delivered on schedule in the most economical form for final fabrication.

Whether you prefer your stainless steel plate as-rolled or unerringly pattern cut to specifications, it will pay you to place your next order with G. O. Carlson, Inc. Stainless steel is our only business. . . .

G. O. CARLSON, INC.

Stainless Steels Exclusively

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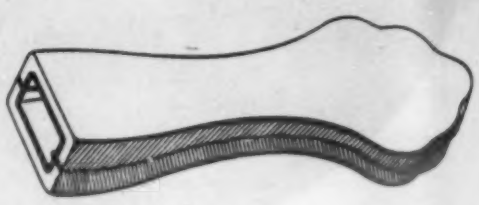
New Materials and Equipment

special shapes and other forms of silver brazing alloy currently used in metal joining. Since the entire joint surface of the parent metal is pre-diffused with silver brazing alloy, voids caused by dry spots and oxide islands are eliminated.

Braze-clad metals can be blanked,



Braze-Clad insures good joints on knife handles and other shell-like parts.

stamped and drawn in the usual manner, whether clad on one or both sides or in inlaid stripes. Extremely ductile, the brazing alloy follows the contours of the forming dies, yet presents a specified bonding thickness at all times.

Typical applications of Braze-clad metals include hollow handles for cutlery and silverware, cap-on-rod joints, hidden joints, seamed tubes and the joining of irregularly shaped parts.

"T" Section Inconel

Availability of hot-rolled Inconel in equal "T" sections has been announced by the *International Nickel Co., Inc.*, 67 Wall St., New York. The "T" sections are made in lengths up to 15 ft. in a standard size 1½ by 1½ by ¼ in. and weigh approximately 2¾ lb. per ft.

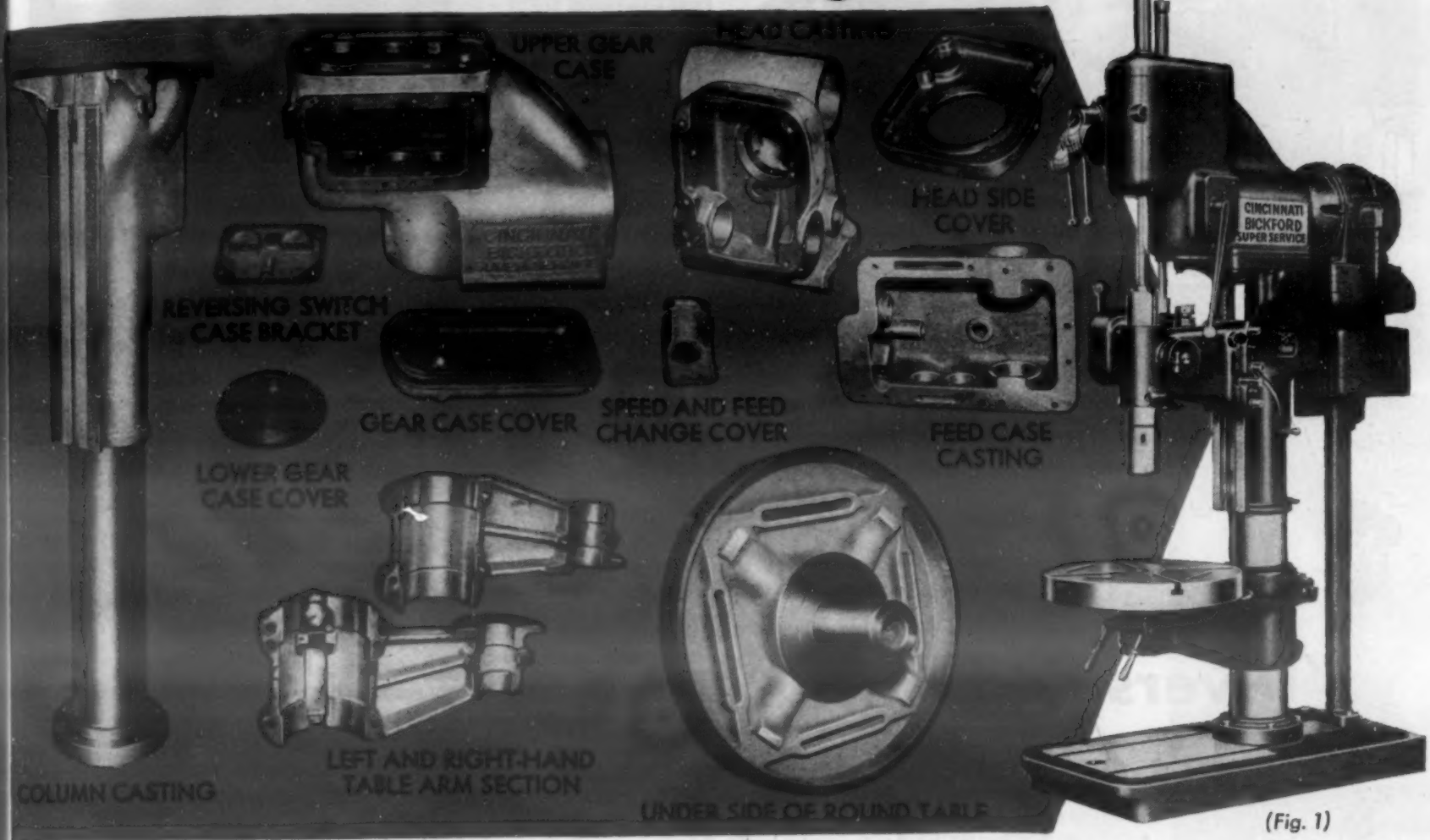
Intended to provide manufacturers of furnaces and other high temperature equipment with ready-made and uniform structural parts, the section can be welded, riveted, or otherwise joined without difficulty.

Corrosion-Proof Instrument Tubing

A new corrosion-proof instrument tubing made of metal with a 1/32-in. coating of extruded thermoplastic has been announced by *Samuel Moore & Co.*, Mantua, Ohio.

Known as Dekoron tubing, it is claimed to be especially useful where a corrosive atmosphere is encountered, the plastic coating being immune to moisture, salt air, oils, acids and alkalies. In addition, the tubing has the advantage of being easily bent, like

ANOTHER Machine Tool Made Better with MEEHANITE® *Castings*



(Fig. 1)

The modern streamlined production tools like the Super Service Uprights (Fig. 1), manufactured by Cincinnati Bickford Tool Company, Cincinnati, Ohio, are built with many Meehanite castings. All of the truly *vital* castings are Meehanite metal. A few are illustrated.

In the manufacture and sale of a machine tool of this type it is a long road between the drawing board and the customers' production floor. The correct specification of proper materials for component parts to translate maximum design superiority into product superiority, is of major importance. That is why wherever quality products are built; where better engineering properties combined with uniformity and repeated dependability are required,—Meehanite castings are specified and insisted upon.

Take advantage of Meehanite engineering service—send your blueprints for analysis and specific recommendation to the foundries listed below.

Take Your Casting Problems To A MEEHANITE Foundry!

American Brake Shoe Co.	Mahwah, New Jersey
The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co.	Irvington, New Jersey
E. W. Bliss Co.	Hastings, Mich. and Toledo, O.
Builders Iron Foundry, Inc.	Providence, Rhode Island
Continental Gin Co.	Birmingham, Alabama
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio and Grove City, Pa.
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co.	Florence, New Jersey
Fulton Foundry & Machine Co., Inc.	Cleveland, Ohio
General Foundry & Manufacturing Co.	Flint, Michigan
Greenlee Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
Johnstone Foundries, Inc.	Grove City, Pennsylvania
Kanawha Manufacturing Co.	Charleston, West Virginia
Koehring Co.	Milwaukee, Wisconsin
Lincoln Foundry Corp.	Los Angeles, California
E. Long Ltd.	Orillia, Ontario
Otis Elevator Co., Ltd.	Hamilton, Ontario
The Henry Perkins Co.	Bridgewater, Massachusetts
Pohlman Foundry Co., Inc.	Buffalo, New York
The Prescott Co.	Menominee, Michigan
Rosedale Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co.	Dover, Ohio
Sonith Industries, Inc.	Indianapolis, Ind.
Standard Foundry Co.	Worcester, Massachusetts
The Stearns-Roger Manufacturing Co.	Denver, Colorado
Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
Valley Iron Works, Inc.	St. Paul, Minnesota
Vulcan Foundry Co.	Oakland, California
Warren Foundry & Pipe Corporation	Phillipsburg, New Jersey

"This advertisement sponsored by foundries listed above."

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ALUMINUM • STAINLESS • ETC.
Plates
CARBON STEEL • STAINLESS
ALLOY • ALUMINUM • FLOOR PLATES
EXPANDED METAL
HAND TOOLS
ROSS SLING HOOKS
PORTABLE ELECTRIC DRILLS
ORDER
ASK ABOUT
BELTING
WELDING ELECTRODES
PROTECTO-METAL COMPOUND

"Diversified stocks" . . .

. . . that's only one of the things we mean by Service Plus!

● Many of our customers think of United States Steel Supply as the "department store" of the steel industry. That's exactly what we aim to be . . . a source of supply that carries a diversified stock of steel, aluminum, tools, equipment and machinery so that customers' requirements can be met. Customers who have shopped around come back to us with comments like these: "Only place we could find what we wanted." "We were hunting an odd size . . . *you had it!*"

You can depend on us for more than diversified stocks, however. *Service Plus* means prompt delivery, and instant, courteous attention to any problems you have involving material selection. It means *You're the Boss* and we're going to do our best to keep you satisfied.

BARS · PLATES · FLOOR PLATE · STRUCTURALS · SHEETS · STRIP
REINFORCING BARS · STAINLESS · ALLOY STEELS · ALUMINUM
TOOLS · EQUIPMENT · MACHINERY

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UNITED STATES STEEL

New Materials and Equipment

ordinary copper tubing, while the plastic coating can serve as color coding for the line.

●

Coatings & Finishes

Protective Coating Steel

Flame spraying of polyethylene coatings on steel tanks, tank cars and processing equipment has been perfected by *Houghton Laboratories,* Orlean, N. Y. Claimed to give greatly improved corrosion protection, the Houghton flame spray process uses no solvents and applies coatings from 1/32 to ¼ in. thick.

After the surface has been sand blasted, polyethylene in powder form is blown through specially designed flame spray equipment. Deposited on the surface in melted form, the polyethylene sets up a tough, non-porous film with high resistance to most chemicals and corrosive materials.

According to the manufacturer, this method of applying protective coatings eliminates danger of pin holes and other defects which might permit corrosion to start. The resulting odorless, taste-free, non-toxic coating is recommended for use in chemical, food, petroleum and metal working industries wherever severe corrosion problems exist.

Hammer Finish

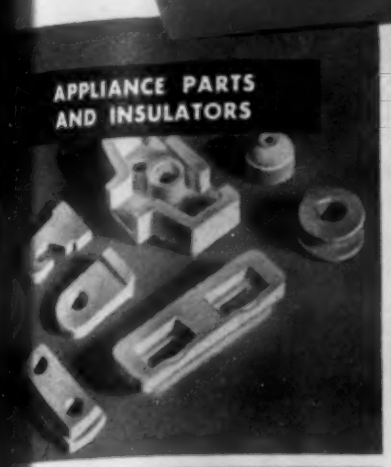
A one-coat hammer-effect finish which can be sprayed on metal parts at the same pressure as regular enamels has been developed by *United Lacquer Manufacturing Corp.,* 1001 W. Elizabeth Ave., Linden, N. J.

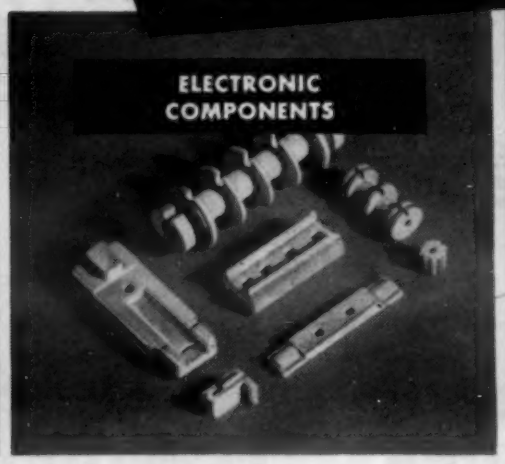
This coating, called Un-i-loid, produces a hammer effect with a smooth, lustrous appearance immediately upon spraying. It is said to be readily reproducible. Baking time is 300 F for 20 min. in a gas oven or 8 min. under infra-red lights.

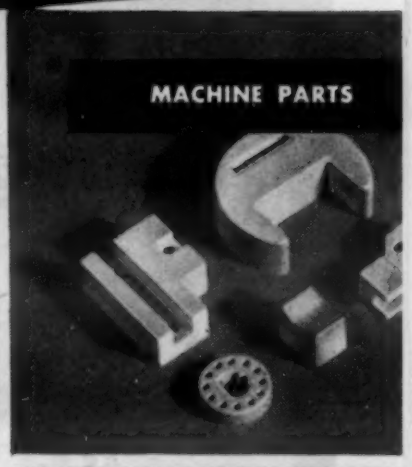
Un-i-loid is available in a full range of colors in either a bake or air-dry finish. The air-dry type is dust-free within a few min-

A Problem?

THE ANSWER MAY BE ALSIMAG®







Your use may be similar to, or completely different from, those listed here . . . yet AlSiMag may solve your problem.

This versatile material is solving production, design and technical problems for many industries. For your business, AlSiMag may offer lower costs, improved manufacturing processes, increased production, or possibilities of a new product.

CAN YOU USE ALSIMAG? AlSiMag is the trade marked name of a large family of technical ceramic compositions. They are now being used in production machines, electronic equipment, chemical processing equipment, gas and electric appliances and in many other consumer products. AlSiMag ceramics are custom made as to physical characteristics, size and shape. Special combinations of raw materials, fluxes, pressures, processes and firing temperatures produce ceramics with characteristics to meet individual requirements. These compositions are fabricated by us into finished parts, ready for your production line.

Given your requirements, our Research Division can frequently develop a special composition to suit your need. Carefully cross-indexed research records usually permit a prompt and accurate reply to inquiries, even if they involve most unusual requirements. If you have a problem that can be solved by a special component of unusual physical characteristics, outline that problem to us. We can indicate the possibilities of its solution by the use of AlSiMag Technical Ceramics. Your inquiry involves no cost or obligation.

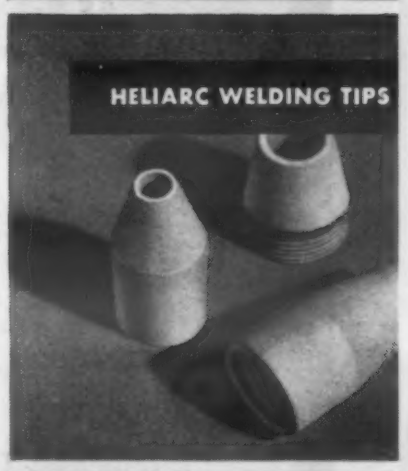
SENT FREE ON REQUEST
The AlSiMag Property Chart 501

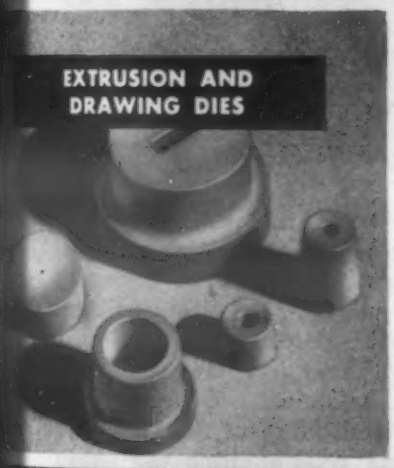
AMERICAN LAVA CORPORATION

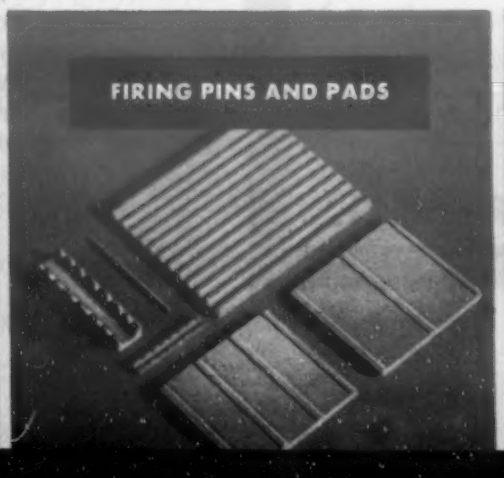
CHATTANOOGA 5, TENNESSEE

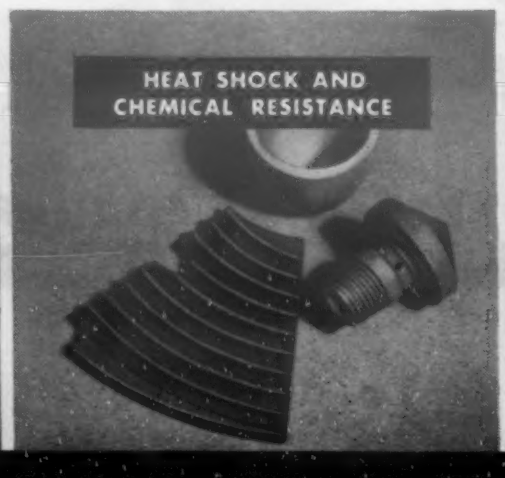
49th YEAR OF CERAMIC LEADERSHIP

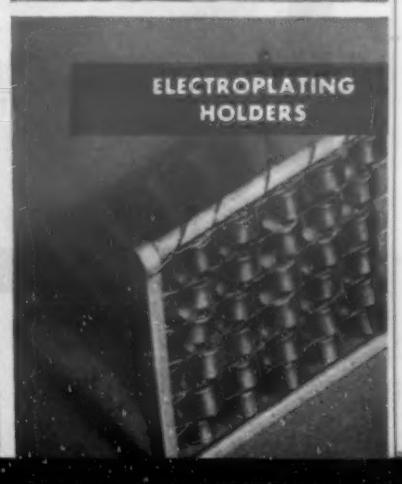
OFFICES: METROPOLITAN AREA: 671 Broad Street, Newark, N. J., Mitchell 2-8159 • CHICAGO, 9 South Clinton Street, Central 6-1721
PHILADELPHIA, 1649 North Broad Street, Stevenson 4-2823
LOS ANGELES, 232 South Hill Street, Mutual 9076
NEW ENGLAND, 38-B Brattle Street, Cambridge, Massachusetts, Kirkland 7-4498 • ST. LOUIS, 1123 Washington Avenue, Garfield 4959











COOPER ALLOY

NEWSCAST

PUBLISHED BY THE COOPER ALLOY FOUNDRY CO., HILLSIDE, N. J.

TECHNICAL INFORMATION ON Corrosion Resistant VALVES · FITTINGS CASTINGS · ALLOYS

A **CATALOG**—New 48 page catalog giving full design, with drawings on the complete line of Cooper Alloy Stainless Valves, Fittings and Accessories.

B **NAMES OF VALVE PARTS**—Design drawings identifying parts and the materials from which they are made.

C **COMPARISON CHART**—2" & ¾" GATE VALVES—Detailed engineering chart comparing features of leading competitive valves.

D **MSS STANDARDS**—Standard Practice SP-42 gives specifications for 150 lb. corrosion resistant cast Flanged Valves, Flanges and Flanged Fittings.

E **FLOW DIAGRAMS**—Basic discussion of valve types—gate, globe, angle, Y, check and tank—with a complete set of diagrammatic sketches to illustrate direction of flow.

F **THREADING STAINLESS STEEL**—Suggested methods of Threading and Assembling Stainless Steel Pipe and Pipe fittings are presented.

G **1950 REFERENCE CHART**—Comprehensive analysis of stainless, corrosion and heat resistant alloy castings—properties, comparative designations, alloy types and nominal analyses.

H **CASTING CENTRIFUGALLY IN PERMANENT METAL MOLDS**—The process and the foundry techniques developed to produce stainless jet engine ring components are thoroughly discussed.

I **CORROSION RESISTANCE OF HIGH ALLOYS**—Technical data sheet on corrosion resistance of stainless, monel and nickel castings.

Yours for the asking!
Just circle letter you want!

A B C D E F G H I

NAME.....

TITLE.....

FIRM.....

ADDRESS.....

CITY ..... STATE..... ZONE.....

The COOPER ALLOY FOUNDRY CO.

New Materials and Equipment

utes after application, and can be handled within an hour. It will also dry hard overnight.

Insulating Tape

Layers of a new insulating and splicing tape made by *Bishop Manufacturing Corp.*, 254 W. 31 St., New York 1, are said to weld into a continuous elastic skin within a few minutes after application.

Based on Bakelite polyethylene resins, the tape remains flexible in temperatures ranging from −30 to 120 F and is said to be unaffected by corrosive fumes, ozone and sunlight. In application, the tape is stretched to two or three times normal length and then wrapped normally, resulting in what is claimed to be a positive, permanent, moisture and air tight seal.

Typical uses are insulation and harness wrapping, and binding wires together or to some rigid object.

Maintenance Coating

A new type of maintenance coating, claimed to be highly resistant to industrial fluids and gases, has been developed by *Stalpic Coating Corp.*, 2310 S. Indiana Ave., Chicago 16. The coating is said to resist acids, alcohol, alkalies, fungi and oils.

Trade-marked "Stalvar," it is reported to withstand a temperature of 300 F for 96 hr. and to have good abrasion and impact resistance, gloss, flexibility and adhesion. Sward Rocker Tests at 70 F indicate hardness ratings of 40 after 5 hr., 70 after 60 hr., and 80 after 10 days.

Protective Tape

Development of a new Scotch brand No-Mar protective tape, said to be designed for especially severe fabrication jobs, including deep draws, has been revealed by *Minnesota Mining and Manufacturing Co.*, 900 Fauquier St., St. Paul 6, Minn. Applied to sheets of stainless steel to protect the surface against scratches and die marks during shipment, storage and fabrication, it can also be used with other highly polished and some plated metals.

The tape, No. 343, is manufactured with an adhesive that not only enables it to stick immediately upon contact but con-

THE BIG TREND IS TO OSTUCO TUBING

PLAYGROUND EQUIPMENT—Greater safety, durability, and beauty, at lower cost. For slides, merry-go-rounds, and many other types of playground equipment. Operations: Bending, flattening, contouring, punching, angle cutting.

CARDIN TRACTORS—Rugged construction, easy maneuverability, light weight. Operations: Tapering, beading, punching, expanding, angle cutting, reaming.

Manufacturers by the hundreds are stepping up sales appeal of their products by using steel tubing to improve design, increase strength, reduce weight, enhance beauty, and cut cost. And as competition grows, more and more users of tubing are switching to OSTUCO Tubing. The reasons are obvious.

Complete modern facilities for performing all three basic tubing operations—manufacturing, shaping, and fabricating—at one plant, enable OSTUCO to provide "Single Source Service" that inevitably speeds deliveries, boosts quality, and reduces final costs.

Expensive, time-consuming shipments from one supplier or one location to another are no longer necessary. Confusion and red tape are eliminated. Responsibility is clearly fixed. Unified control of production assures precision in meeting your most exacting requirements.

OSTUCO produces both seamless and electric welded steel tubing in a broad range of sizes and shapes . . . performs *all* types of forging and fabricating operations . . . supplies finished or semi-finished products. Write direct or to our nearest sales office for informative free booklet "Fabricating and Forging Steel Tubing."

THE OHIO SEAMLESS TUBE COMPANY

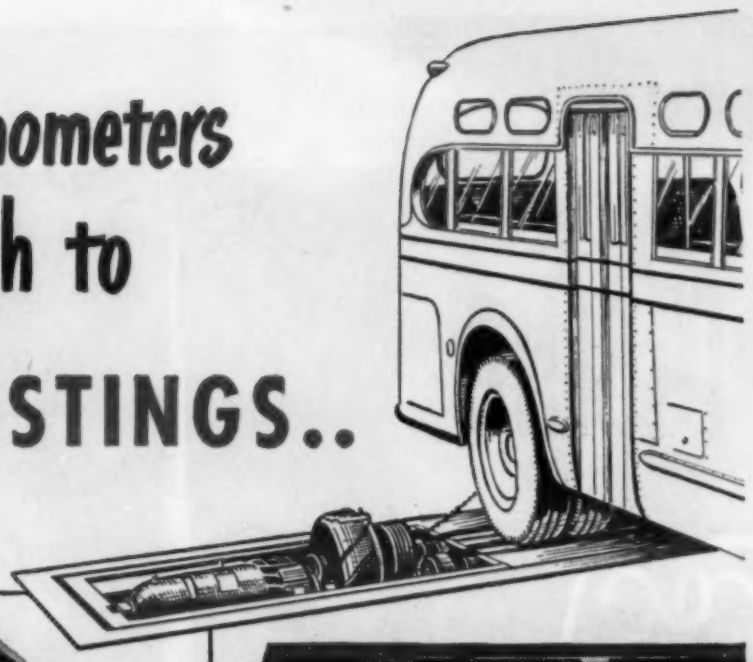
Manufacturers and Fabricators of Seamless and Electric Welded Steel Tubing

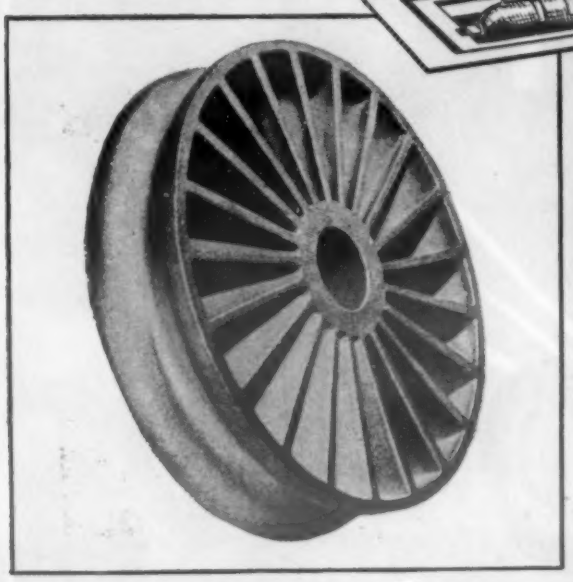
Plant and General Offices: SHELBY 11, OHIO

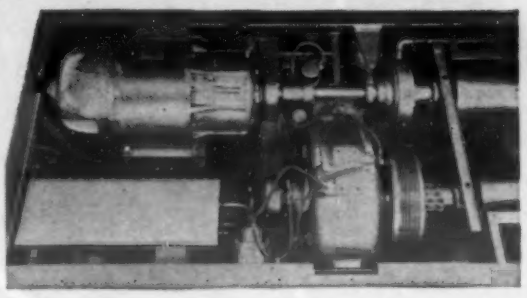
SALES OFFICES: BIRMINGHAM, 1700 Huntsville Rd. • CHICAGO, Civic Opera Bldg., 20 N. Wacker Dr. • CLEVELAND, 1328 Citizens Bldg. DAYTON, 511 Salem Ave. • DETROIT, 520 West Eight Mile Rd., Ferndale • HOUSTON, 6833 Avenue W, Central Park • LOS ANGELES, Suite 300-170 So. Beverly Drive, Beverly Hills • MOLINE, 617 15th St. NEW YORK, 70 East 45th St. • PHILADELPHIA, 1413 Packard Bldg., 15th & Chestnut • PITTSBURGH, 1206 Pinewood Drive • ST. LOUIS, 1230 North Main St. • SEATTLE, 3104 Smith Tower • SYRACUSE, 501 Roberts Ave. • TULSA, 114 East Fifth St. • CANADIAN REPRESENTATIVE: RAILWAY & POWER CORP., LTD., New Glasgow, Montreal, Noranda, North Bay, Toronto, Hamilton, Windsor, Winnipeg, Edmonton, Vancouver.

From Your Blueprint . . . to Your Product
OSTUCO TUBING
Tapering • Swaging • Flanging • Bending
Upsetting • Expanding • Reducing • Beading
End closing • Spinning • Drilling • Slotting
Notching • Flattening • Shaping • Trimming
Threading • Angle Cutting • And Many Others

Dynamometers switch to UNITCASTINGS..







with Unitcastings

- GREATER STRENGTH
- LESS BREAKAGE
- GREATER SAFETY

KEEP BUSSES IN TOP RUNNING EFFICIENCY!

This Bennett-Feragen Dynamometer, designed for testing the horsepower of internal combustion engines, helps keep bus transit systems at peak operating efficiency. In actual testing operations, however, parts of the Dynamometer rotate at very high speeds. The illustrated impeller was switched to Unitcastings from other metal products to gain greater strength with less danger of breakage and provide greater testing safety. If your problem concerns special alloys, difficult casts, close tolerances, see what Unitcastings can do to build quality into your product.

UNITCAST *Corporation*
QUALITY STEEL CASTINGS

Give us a chance to offer a "cast steel" answer for your parts problem. Our suggestions while your product is in the design stage will pay continuous dividends. Write or call today. Unitcast Corporation, Steel Casting Division, Toledo 9, Ohio. *In Canada:* Canadian-Unitcast Steel, Ltd., Sherbrooke, Quebec.

UNITCASTINGS ARE FOUNDRY ENGINEERED

New Materials and Equipment

stitutes a rubbery protective film that stretches with the metal during fabrication. Wrinkling is eliminated during storage by a white paper backing on which pattern can be easily traced.

Anti-Rust Primer

A new clear anti-rust primer has been developed by *Speco, Inc.*, 7308 Associate Ave., Cleveland 9. Known as Rustrem Clear, it can be brushed or sprayed directly over rust without preliminary wire brushing or scraping.

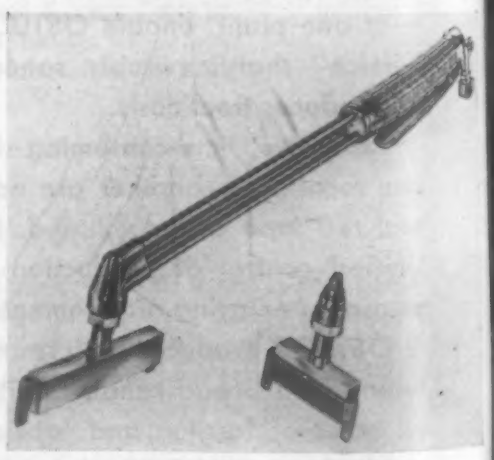
In addition, the primer can be painted over with any good quality paint except lacquer, and will not bleed through painted surfaces.

●

Cleaning & Finishing

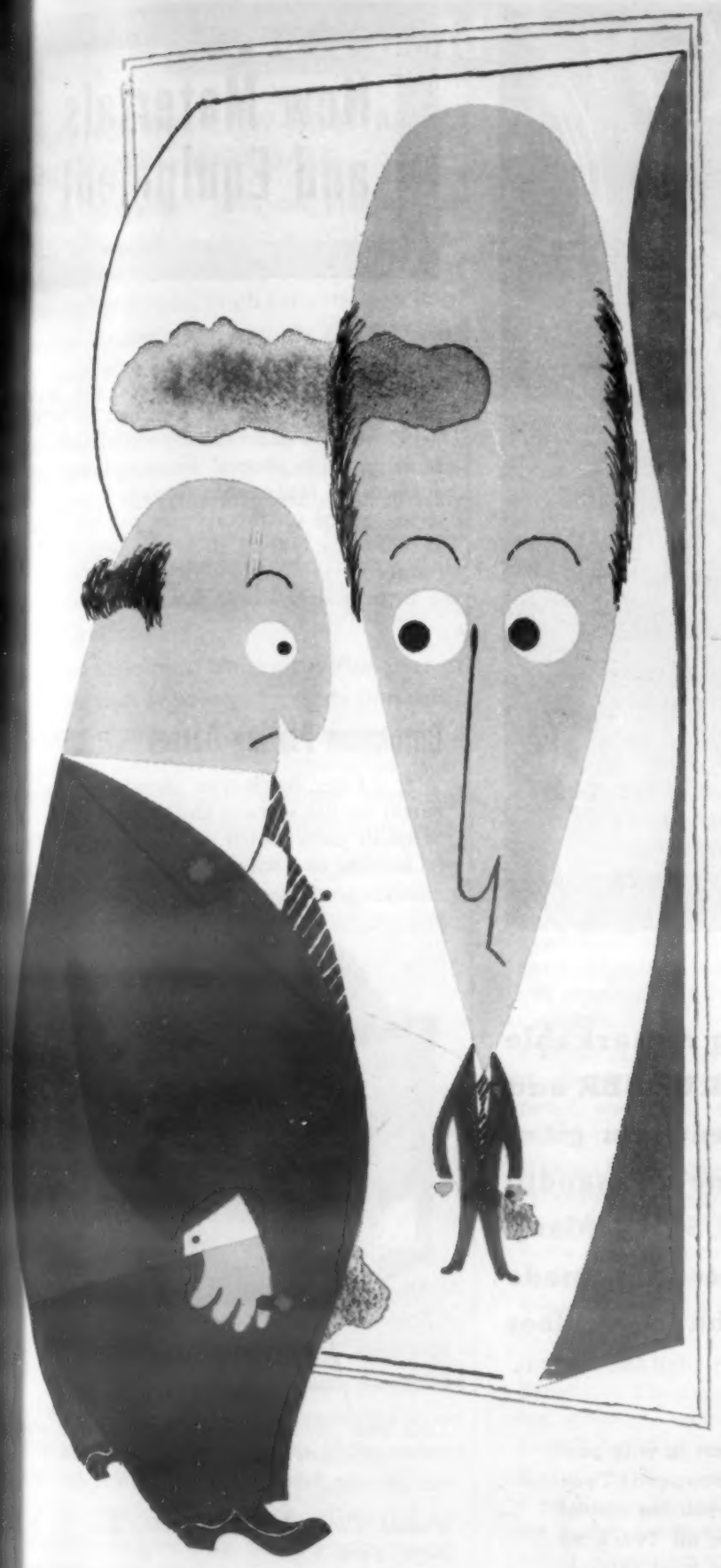
Paint Remover Burner

A new burner for removing paint from metal surfaces has been developed by *National Cylinder Gas Co.*, 840 N. Michigan Ave., Chicago 11, Ill.



Use of a pure flow of oxygen in addition to an oxy-acetylene flame is a feature of this new paint removal burner.

Also effective in removing scale and rust and dehydrating the surface, the burner supplements the usual oxy-acetylene flame with a low-velocity flow of pure oxygen re-



don't get the wrong impression

It's easy to get the distorted idea that stainless steel is a "miracle metal," but after all, stainless is a *family of alloys*, and careful consideration must be given to the *right* analysis to use . . . or stainless won't live up to advance notices. Crucible, pioneers in the development of these specialty steels, makes freely available to you an alert metallurgical staff to help you put Crucible Stainless to work most efficiently in your application.

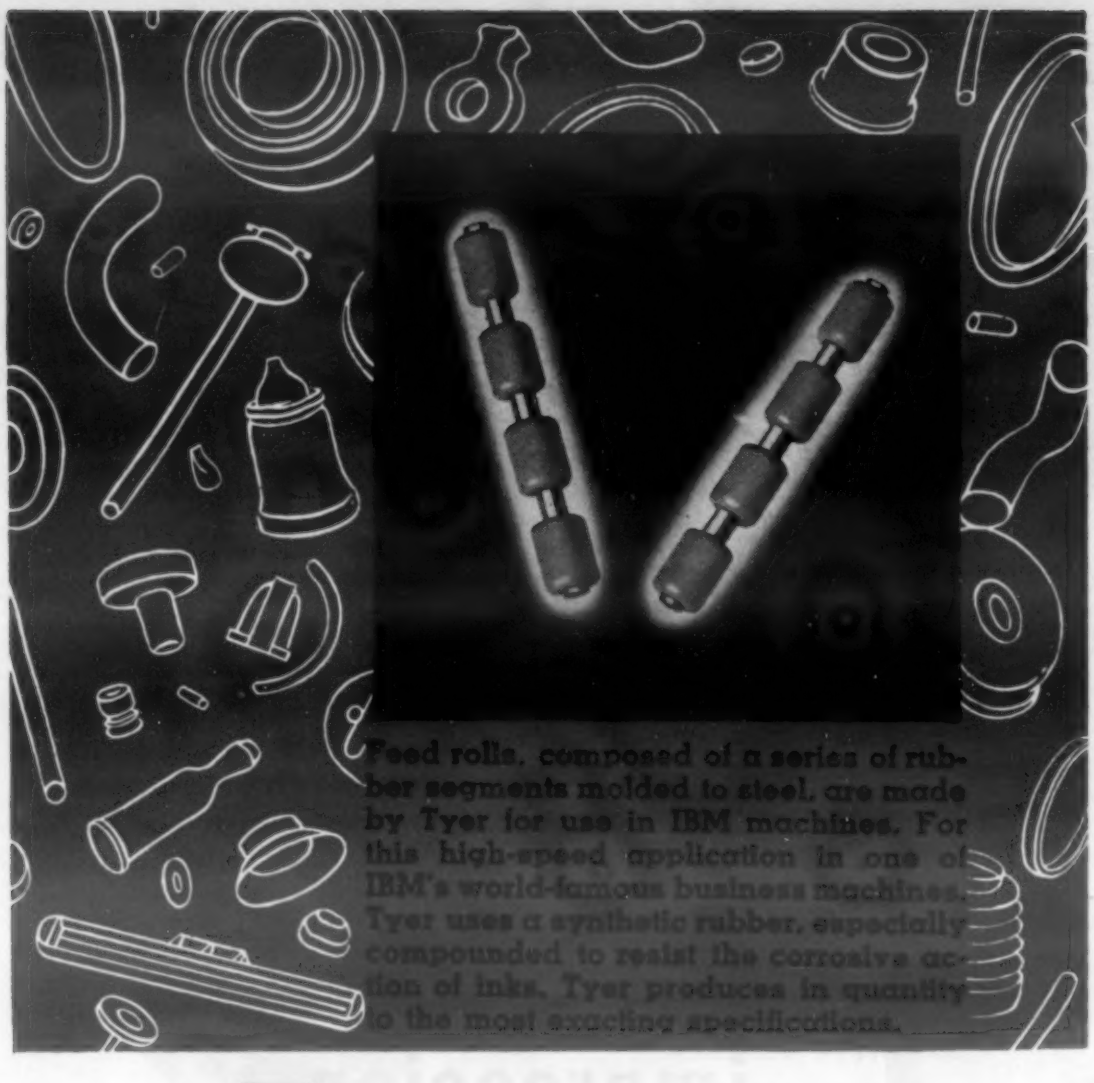
Crucible's half century of specialty steel leadership is based on a keen devotion to detail in every industry-posed problem. That's why Crucible built, from the ground up, one of the first integrated mills designed specifically for the hot and cold rolling of stainless steels. Take full advantage of Crucible's specialty steel experience. Call us in to work for you. CRUCIBLE STEEL COMPANY OF AMERICA, Chrysler Building, New York 17, N. Y.

CRUCIBLE first name in special purpose steels

STAINLESS STEELS

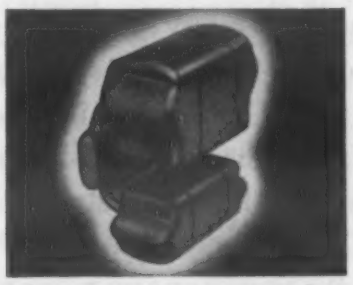
fifty years of Fine *steelmaking*

STAINLESS • HIGH SPEED • TOOL • ALLOY • MACHINERY • SPECIAL PURPOSE STEELS



Feed rolls, composed of a series of rubber segments molded to steel, are made by Tyer for use in IBM machines. For this high-speed application in one of IBM's world-famous business machines, Tyer uses a synthetic rubber, especially compounded to resist the corrosive action of inks. Tyer produces in quantity to the most exacting specifications.

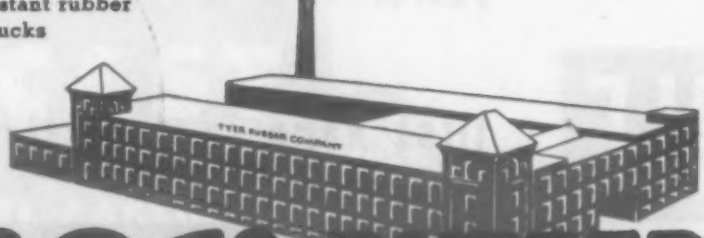
For 94 years Tyer has been doing remarkable things with rubber. Tyer originated WHITE RUBBER and ELASTIC WEBBING. Tyer's war products ranged from giant pontons to tiny earplugs made to a tolerance of one thousandth of an inch. Today Tyer leads in SERVICE to INDUSTRY. Many of the country's finest products have vital rubber parts made by Tyer. These famous manufacturers know that Tyer does unusual things with rubber.



A shock insulator made by Tyer of a high-grade, resilient, oil and weather resistant rubber compound to protect heavy trucks from road shocks.

If there is a rubber part in your product (old, new or proposed) Tyer technicians will give you the utmost cooperation in putting all Tyer's 92 years of experience at your service. Ask the Tyer representative. Write to us in Andover or to the nearest branch.

*



Tyer RUBBER COMPANY

* ANDOVER, MASSACHUSETTS

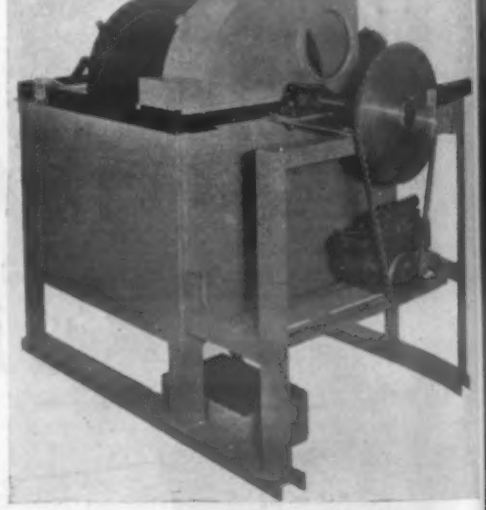
159 Duane St., NEW YORK 189 W. Madison St., CHICAGO 3-252 Gen. Motors Bldg., DETROIT

New Materials and Equipment

sulting in rapid oxidation of the heated paint. Designed to be attached to NCG Torchweld 75 hand cutting torch, the burner is kept at a proper distance from metal surfaces by replaceable, wear-resistant guide shoes. Speed on the average painted surface is said to be 600 sq. ft. per hr., using a 4 in. burner.

Chromium Plating Barrel

A 24-in., batch-type chromium plating barrel for use in hard and decorative plating of small parts which are expensive to plate in baskets or racks has been developed by



This new chromium plating barrel is used for small parts too expensive to plate in baskets or on racks.

United Chromium, Inc., 100 East 42 St., New York 17.

Called the Unichrome Chromium Plating Barrel, its capacity is dependent upon the size and shape of the work. One manufacturer is said to plate between 100,000 and 500,000 pieces in one barrel every eight hour day. Maintenance of the self-regulating solution used in the barrel is simple, water and Unichrome S.R.H.S. salts being the only additions necessary.

Etching Compound

Development of Pennsalt AE-18, a highly concentrated alkaline compound for etching aluminum without forming hard sludge deposits on the bottom of the etching tanks, has been announced by the *Special Chemical*

You Should Know These FACTS ABOUT PLASTICS!

PLASTICS ARE LOW-COST BASIC INDUSTRIAL MATERIALS

Most published data on plastics are written around their multitudinous uses, as industrial components and as consumer goods. Such information is of value insofar as it reveals the growing popularity and increasing acceptance of plastics.

Yet, there remains the need to clarify for management and operating executives of American business the basic reasons why plastics—in the past 10 years—have grown six-fold from a 200,000,000 to a 1,200,000,000 pound annual business.

The adjoining chart provides part of the answer. It shows the costs per cubic inch of a variety of materials including plastics and metals. Its purpose is to place plastics properly in the industrial scheme. It is not intended to draw misleading comparisons between these materials, all of which are serving industry so well and which will grow in usefulness as the national economy expands.

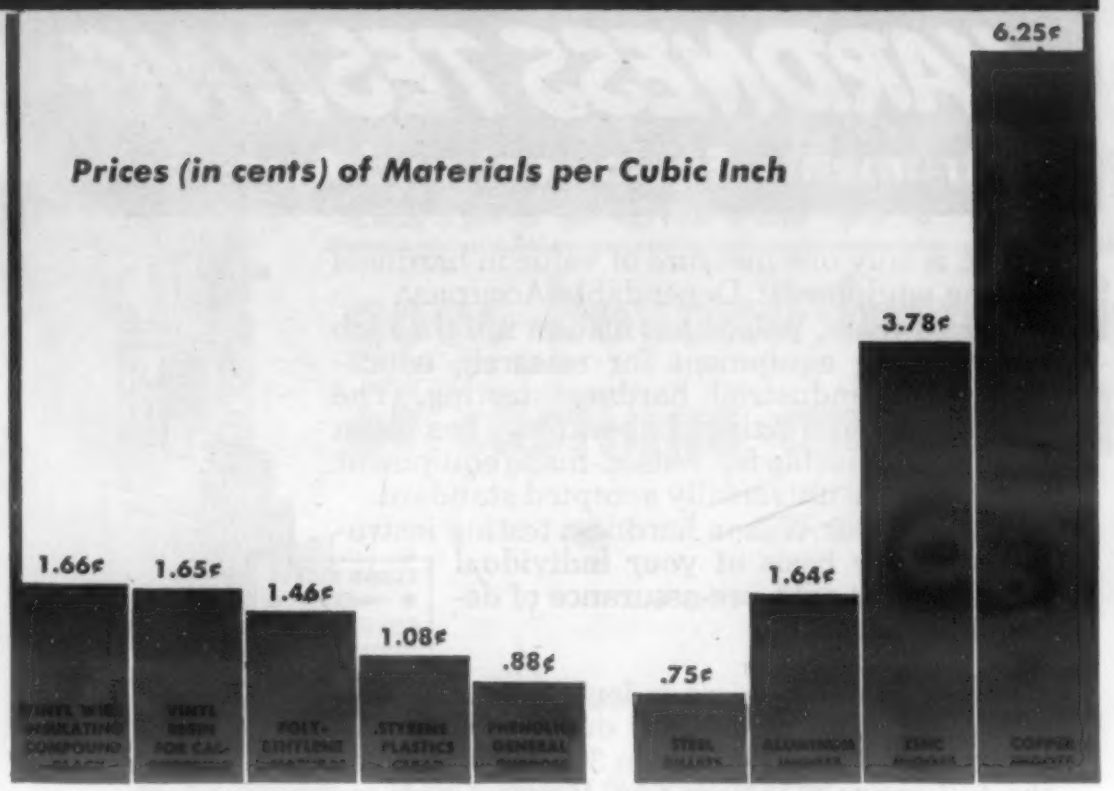
BAKELITE DIVISION, LEADING PRODUCER OF PLASTICS

Bakelite Division of Union Carbide and Carbon Corporation ranks as the largest producer of plastics in the world, excluding the synthetics that are not commonly regarded as plastics. While Bakelite Division does not sell all types of plastics, it does sell those that are in greatest demand such as Phenolics, Polyethylenes, Styrenes, and Vinyls.

These plastics take such forms as film and sheeting, rigid sheets, resins for coatings and adhesives, molding, calendering, and extrusion compounds, and resins developed for such industrial operations as bonding, laminating, gluing, and impregnating.

NEW USES SPUR DEMAND

There are other reasons for the phenomenal growth in the demand for plastics. Many improvements have been made in the quality and efficiency of plastics and their processing. New types and forms of plastics have resulted from the huge investment in research and development. Above all, industry has become more familiar with plastics and has learned to take the fullest advantage of their many valuable properties. Examples are given in the next column.



Specific gravity × .03605 × price per pound in cents = cents per cubic inch.
Prices in effect August 1, 1950, apply only to primary or basic materials;
Sources: "Engineering and Mining Journal," and Bakelite Division's price lists.

BAKELITE Polyethylene for blown bottles that are shatterproof, make extremely good looking, light-weight packages that save shipping costs, eliminate breakage, are squeezable for easy application of the contents.

BAKELITE Polystyrene emulsions provide the bases for wholly new types of waterproof, washable, water-thinned paints for exterior and interior service.

BAKELITE Phenolic plastics, used with Heatronic preheating are now molded in extremely large sizes... for example, one-piece television cabinets weighing twenty pounds or more.

VINYLITE plastics for electrical insulation, in distinguishing colors, are used for insulated wire, light in weight and small in diameter. They increase efficiency of wiring systems, make possible non-metallic sheath building wire.

BAKELITE Polyethylene film has become a prime medium for packaging, especially for frozen foods and produce which must reach consumers garden fresh.

BAKELITE Styrenes for wall tiles combine such desirable features as: decorators' colors, beautiful finish, lightness in weight, ease of application to a variety of wall surfaces, and low cost.

VINYLITE plastic film and sheeting has transformed a whole nation's tastes with respect to shower curtains, draperies, window shades, rainwear, and inflatables.

BAKELITE Phenolic resins are employed as the bonding media for such applications as: glass-and-mineral wool thermal insulation, abrasive products, brake linings, and foundry sand molds and cores.

BAKELITE Styrene Plastics are widely used for housewares and toys because, at low cost, they provide a high degree of serviceability, pleasing designs and gay, cheerful colors.

VINYLITE plastic flexible molding materials have provided a new concept of resilient parts for vacuum cleaners, luggage, and products such as hair curlers and dolls.

THE FUTURE FOR PLASTICS

The demand for plastics, particularly the types sold by the Bakelite Division, is continually increasing and there are times when demand may outstrip supply. New production facilities are now under construction to take care of rising and future demands. Manufacturers who are considering the use of plastics to improve their products are counseled to make their needs known now to the Bakelite Division so that they may benefit from its more than 40 years experience in the field of plastics. It is of utmost importance that the right plastics be used in the right places. By consulting Bakelite engineers, manufacturers can be assured that they will be using the correct materials for the job and that their products are designed to take maximum advantage of the properties and economic features of "Bakelite" and "Vinylite" plastics. Inquiries to Dept. AU-17 will receive prompt, thorough and confidential handling.

Bakelite
TRADE-MARK
PLASTICS
BAKELITE DIVISION UCC

The terms "Bakelite" and "Vinylite" are registered trade-marks of

BAKELITE DIVISION, *Union Carbide and Carbon Corporation,* **30 East 42nd Street, New York 17, N. Y.**

The Universally Recognized Leader in

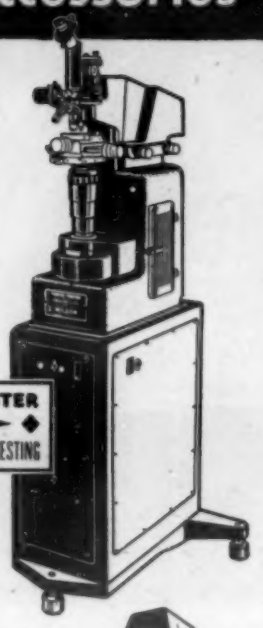
HARDNESS TESTING

Instruments, Equipment and Accessories

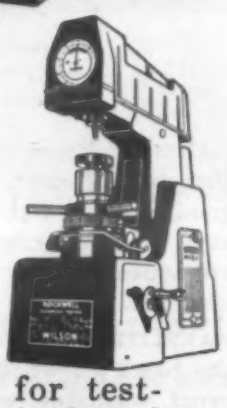
There is only one measure of value in hardness testing equipment: Dependable Accuracy.

For 28 years, Wilson has made a full time job of providing equipment for research, educational and industrial hardness testing. The Wilson Standardizing Laboratory has been largely responsible for Wilson-made equipment becoming the universally accepted standard.

Choose your Wilson hardness testing instrument on the basis of your individual requirements with pre-assurance of dependable accuracy.



TUKON—for micro-indentation hardness testing with either Knoop or 136° Diamond Pyramid Indenter. Made in 3 models to cover the full range of Micro and Macro Hardness testing with loads from 1 to 50,000 grams.



"ROCKWELL" Hardness Tester developed and made only by Wilson. For laboratory, toolroom or production line testing. Vertical capacities from 3¼" to 16". Motorized models available.

"ROCKWELL" *Superficial*

HARDNESS TESTER—especially suited for testing thin material, nitrided or lightly carburized steel and areas too small for regular "ROCKWELL" Hardness Tests. Depth of indentation .005" or less. Satisfactory for general testing where surfaces are smooth and materials homogeneous.

ACCESSORIES

"*BRALE*" is the only diamond indenter made to Wilson's precision standards. • *TEST BLOCKS*—enable you to keep your instrument "Laboratory" accurate. • *EQUITRON*—fixture provides means for accurately positioning test samples. • *ADAPTER*—permits testing inner cylindrical surfaces with unimpaired accuracy. • *WORK SUPPORTS*—facilitate testing of variously shaped rod stock, tubing or irregular shapes.

FOR DETAILED INFORMATION

—fill in the coupon below and mail to us.

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"ROCKWELL" Superficial ☐ Accessories ☐

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COMPANY NAME _____

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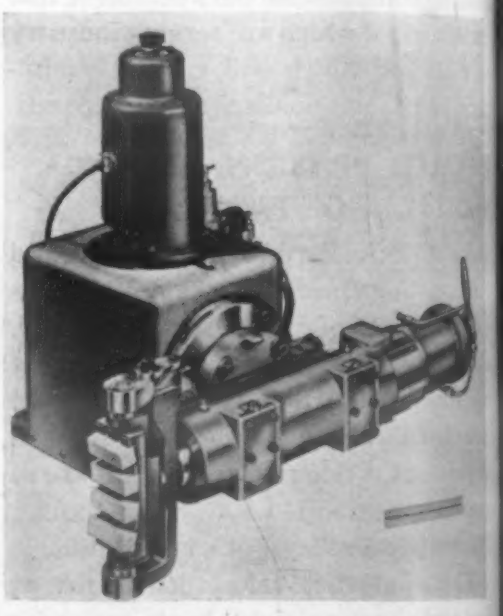
New Materials and Equipment

Dept., Pennsylvania Salt Mfg. Co., 1000 Widener Bldg., Philadelphia.

Recommended for use in concentrations of five to seven ounces per gallon of water at temperatures of 140 to 150 F, the new etching compound is said to give a bath of long life and assure uniform etching in addition to eliminating the sludge deposits.

Superfinish Attachment

A superfinishing attachment that can provide up to 1000 psi. pressure with an adjustable oscillation rate of from 42 to 250 strokes per min. has been developed by the



The new No. 4 superfinishing attachment can provide up to 1000 psi. pressure.

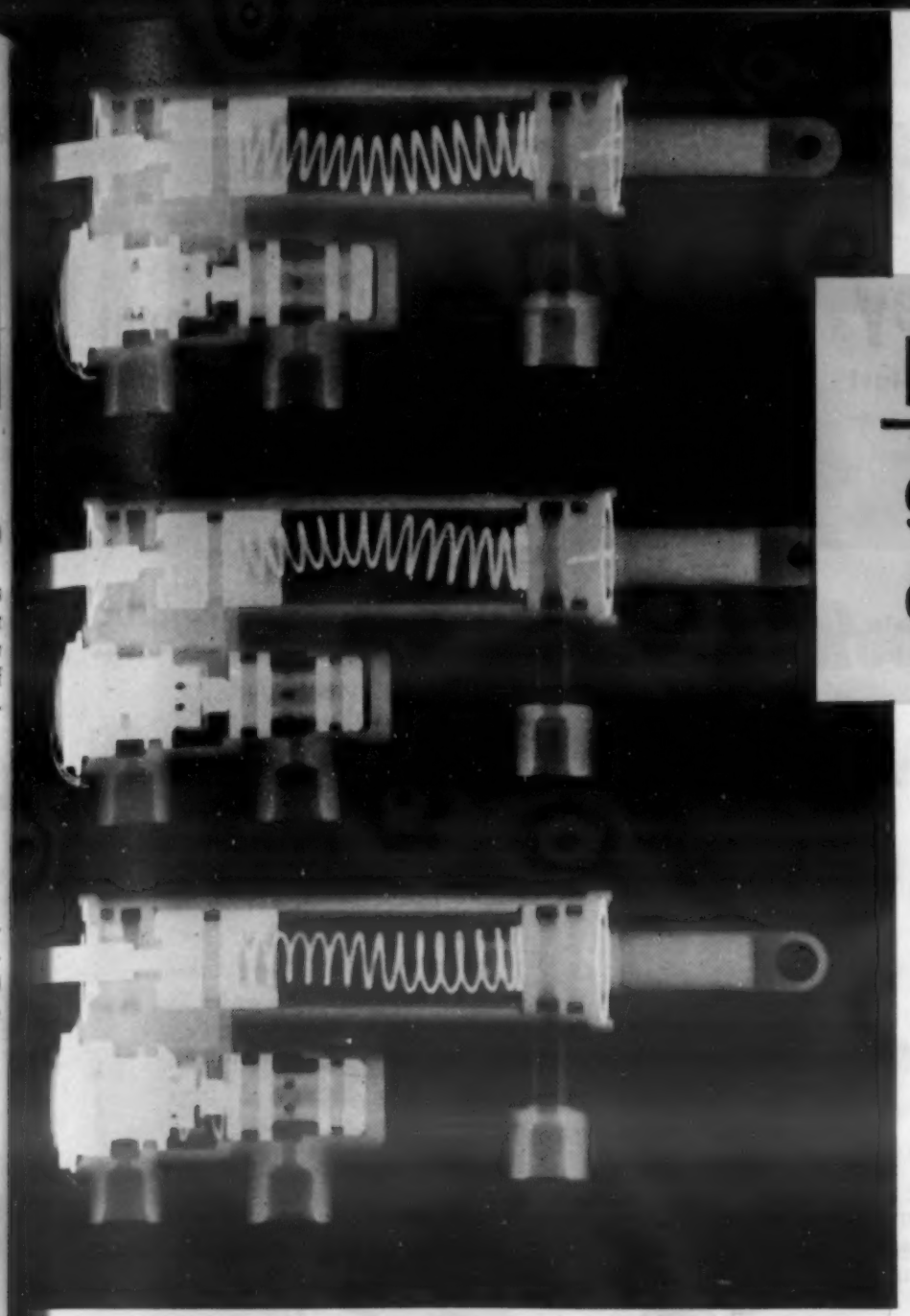
Gisholt Machine Co., 1379 E. Washington Ave., Madison 10, Wisc.

Designated No. 4, it can be used on either ground or machined surfaces, although working time is considerably longer when the surface has not been previously ground. No. 4 is designed to be mounted on an engine lathe or other similar equipment.

Liquid Abrasive

A liquid abrasive which is claimed to be greaseless, non-flammable and quick drying has been perfected by the *Lea Manufacturing Co.,* Waterbury, Conn.

Named Leabrament, the abrasive is used for burring and polishing and is available in grit sizes from 100 to fine micron. It can be sprayed or brushed on polishing and buffing wheels and is suitable for hand or automatic production methods.

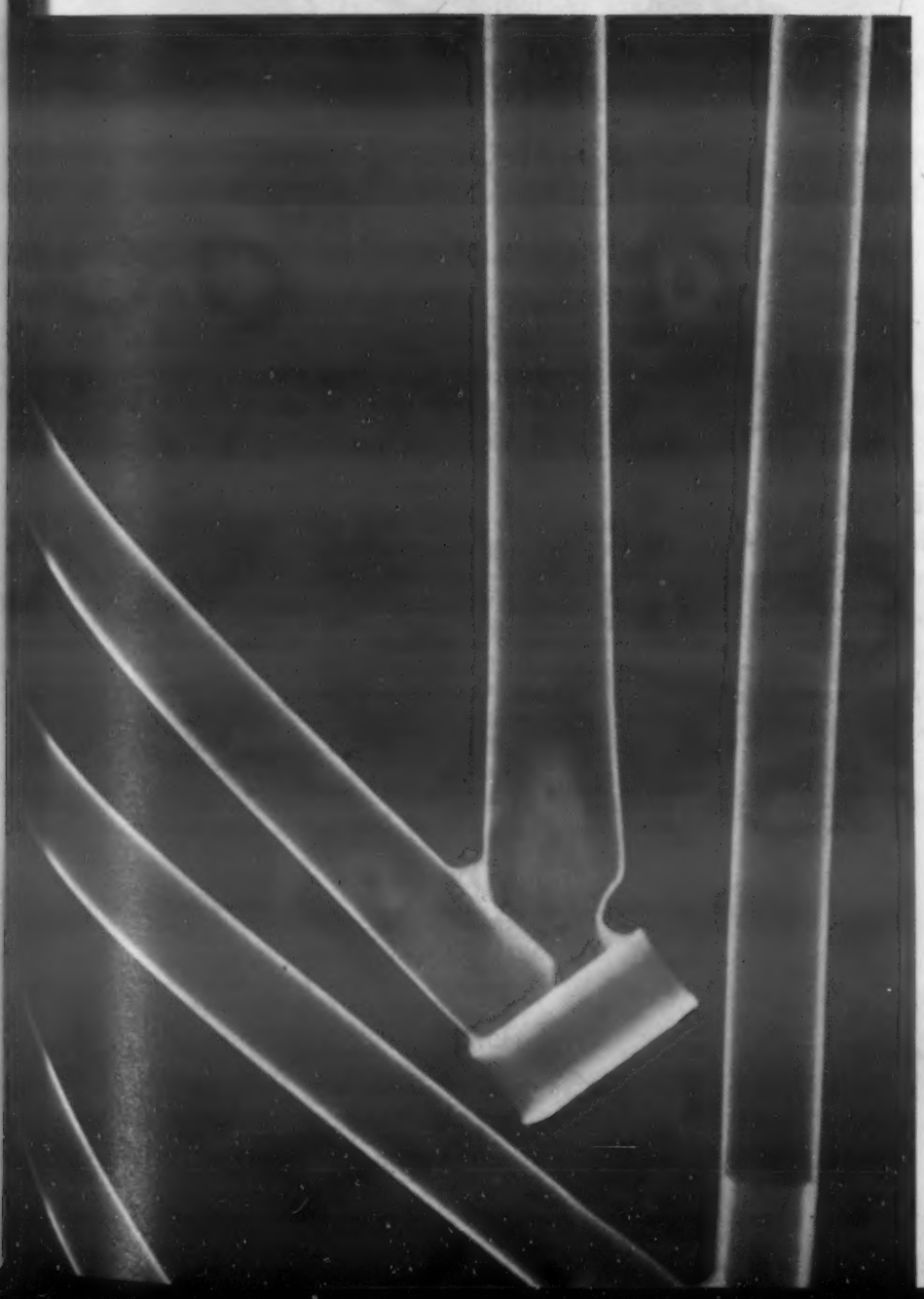


RADIOGRAPHY

goes beyond inspection of castings and welds

CHECKS ASSEMBLIES

Two of a group of hydraulic cylinders failed to function. Disassembly would have taken too long and involved breaking seals. Radiography compared the two with a good cylinder and revealed not only the compression springs rubbing on cylinder walls but also the absence of a second coil spring in the valve assemblies.



EXAMINES ENCLOSED SURFACES

Even though treated and sealed, these landing gear struts of an amphibian plane can develop internal corrosion and become weakened. Radiography alone can provide an examination of these internal surfaces. So the manufacturer has made it routine in the periodic inspection for service and safety of its amphibians.

Your x-ray dealer will gladly discuss the many ways radiography can aid your business by increasing foundry yield, checking welds and doing many other important and valuable non-destructive inspections.

EASTMAN KODAK COMPANY
X-Ray Division, Rochester 4, N. Y.

Radiography . . .

another function of photography

Kodak
TRADE-MARK

Which of these Machines will Save You Money

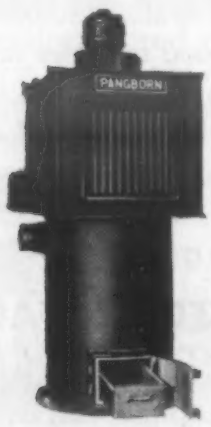
These factory-assembled units of Pangborn Blast Cleaning and Dust Control machines are especially designed to earn extra profits where special equipment is not required.

BLAST CLEANING CABINET
cleans metal parts, removes rust, scale, grime, dirt, paint, etc., in a few seconds. Ideal unit for producing clean, smooth surface on pieces up to 60″ x 36″.

BLAST CLEANING CABINETS $290.00 and UP

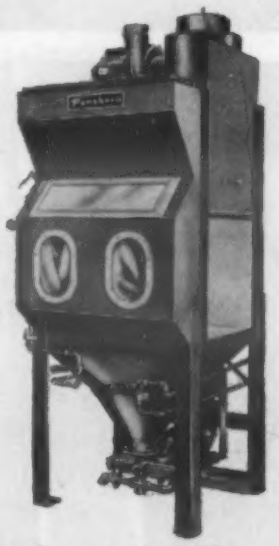
BLAST CLEANING MACHINE
for maintenance and many other uses including the removal of rust, dirt, scale, etc. Economically cleans large objects such as tanks, bridges, structural work preparatory to painting. Six sizes, stationary or portable.

BLAST CLEANING MACHINES $155.00 and UP



UNIT DUST COLLECTOR
traps dust at its source, minimizes machine breakdowns, reduces housekeeping and maintenance costs. Solves many grinding and polishing nuisances and material losses.

UNIT DUST COLLECTORS $260.00 and UP



HYDRO-FINISH CABINET
uses liquid blast, eliminating dust, and reduces costly hand polishing, cleaning and finishing of molds, dies, tools, etc. Removes scale, discoloration and directional grinding lines, prepares surfaces for plating and coating. Holds tolerances to .0001″.

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Gentlemen: Please send me further information on—
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I am interested in the possibility of using one of these machines for.....
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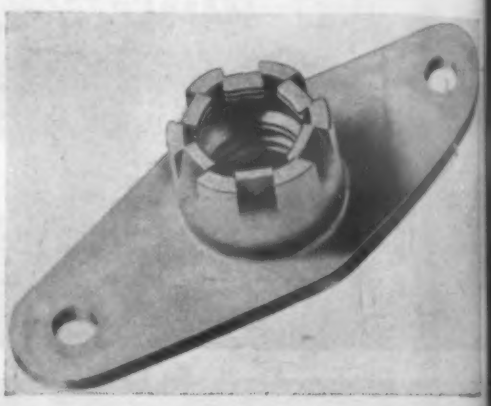
Pangborn

New Materials and Equipment

Welding & Joining

Self-Locking Nut

The "Plate-Lok", first of a new series of self-locking nuts employing the Hex-Lok principle, has been announced by *Boots Aircraft Nut Corp.*, Stamford, Conn. Up to this time, the original Hex-Lok has been available only in the hexagon type nut.



The Plate-Lok is available in 8/32-, 10/32- and 1/4-in. sizes, and can be used from below zero to 550 F.

The top or locking section of the one-piece nut is formed by depressing six threaded flanges inward and downward so that they exert positive pressure against the body of the bolt without distorting or breaking the bolt threads. These flanges are held by tension in this condition, and return to a depressed position when the bolt is removed.

New Industrial Welders

Welding heat adjustment is accomplished electrically through an a.c.-d.c. reactor in the new line of a.c. transformer welders recently announced by *Hobart Brothers Co.*, Hobart Square, Troy, Ohio.

With a design that provides "pre-surge" instantaneous arc striking, eliminating the necessity for relays, and sufficient ventilation, which removes the necessity for a cooling fan, this new welder is completely free from moving parts. The units are said to be extremely safe to operate, with only 20 v. across the control rheostat and as low as 30 v. across the electrode holders at no-load.

Available in 50 or 60 cycle and 220/440, 440/550 or 220/440/550 v., these welders can be adapted to both inert-gas-shielded arc and spot welding.

Want to Save $5000 per Year?

SHOWN INSPECTING RADIATOR PARTS BEFORE AND AFTER CLEANING, C. N. Deubner and Floyd Wells of Yates-American Machine Co. agree: "ROTOBLAST saves money!" Five old-style machines have been replaced by the one ROTOBLAST Barrel shown in the smaller photo. Cash savings each year total more than $5000—proof ROTOBLAST is economical!

ROTOBLAST

SAVES LABOR: *One ROTOBLAST machine and operator can do as much as a two-man crew and old-fashioned equipment.*

SAVES SPACE: *In many cases, one ROTOBLAST machine replaces five or more old-fashioned machines, requires less space.*

SAVES TIME: *Cases on record prove ROTOBLAST can cut cleaning time up to 95.8% compared with old-style methods.*

SAVES POWER: *Modern ROTOBLAST uses but 15-20 h.p. compared to old-fashioned equipment requiring 120 h.p. for same job.*

SAVES TOOLS: *On work cleaned with ROTOBLAST, cutting tools last up to 2/3 longer because no scale is left to dull edges.*

. . . and these savings mean INCREASED PROFITS for you!

Read how manufacturers save money with Pangborn ROTOBLAST*!

Authentic cases in our files *prove* Pangborn ROTOBLAST *saves money* on blast cleaning. For example, take this performance at Yates-American Machine Co., manufacturers of high-quality heat transfer products. Since ROTOBLAST went into operation they have saved more than $5000 a year on blast cleaning!

Other Pangborn users report equally impressive annual savings of five, ten, eleven thousand dollars *and more* when ROTOBLAST takes over a blast cleaning job. Throughout industry, for companies like General Electric, General Motors, Ford . . . ROTOBLAST saves time and labor, and keeps cleaning costs low *without sacrificing quality!*

WHAT ABOUT YOUR PLANT?

If you clean castings, forgings or heat-treated parts, and if you want to save time, money and manpower . . . find out about ROTOBLAST. There's a standard Pangborn Table, Barrel, Room or Table-Room designed for every cleaning job. To get specifications, descriptions and full facts, write for Bulletin 214. Just address: PANGBORN CORPORATION, 1700 Pangborn Blvd., Hagerstown, Md.

Look to Pangborn for the Latest Developments in Blast Cleaning and Dust Control Equipment

MORE THAN 25,000 PANGBORN MACHINES SERVING INDUSTRY

Pangborn

FOUNDRY EQUIPMENT MANUFACTURERS ASSOCIATION MEMBER FEMA

*Trademark of Pangborn Corporation

BLAST CLEANS CHEAPER with the right equipment for every job

FASTER . . . EASIER

PRECISION DEW POINT INDICATOR

★ The Alnor is the only dew point indicator that is a complete unit in itself . . . it is readily portable and does not require external coolants or auxiliary apparatus.

★ Controlled testing conditions are assured. Indications take place in an enclosed chamber . . . dew or fog is observed suspended in air—not on a polished surface. This means greater accuracy, faster reading—*every time*.

★ Simple, direct operation of the Alnor Dewpointer assures laboratory accuracy by non-technical personnel. Substantial carrying case protects it against the usual hazards of portable use.

★ Available in three ranges—for dew points between minus 20 deg. F. and room temperatures from minus 80 deg. F. to 0 deg. F., and from 80 deg. F. to room temperature.

Alnor

Write for Descriptive Bulletins. Illinois Testing Laboratories, Room 522, 420 N. LaSalle St., Chicago 10, Ill.

PRECISION INSTRUMENTS FOR EVERY INDUSTRY

New Materials and Equipment

Plastic-Metal Screw

A screw which is comparable in st and accuracy to a standard metal scre which is said to have the additional a tages of electrical insulation, shock resi and vibration damping has been anno by *Forman Insulating Screw Corp.*, Broadway, New York 13.

Basically, the new fastener consists serrated metal core which has been e sion-coated with a thermoplastic ma After the extrusion process, the com rod is cut in an automatic screw ma The metal core, which runs the entire l of the screw, carries the torque appli the screw driver or other driving instru thus eliminating the possibility of the p either chipping or cracking under tor

Greatest advantage claimed for the screw is a saving in parts and ass time, accomplished by making the insu an integral part of the fastener. Also, th limited color range in which the fas are available make production coding si

Welding Electrode

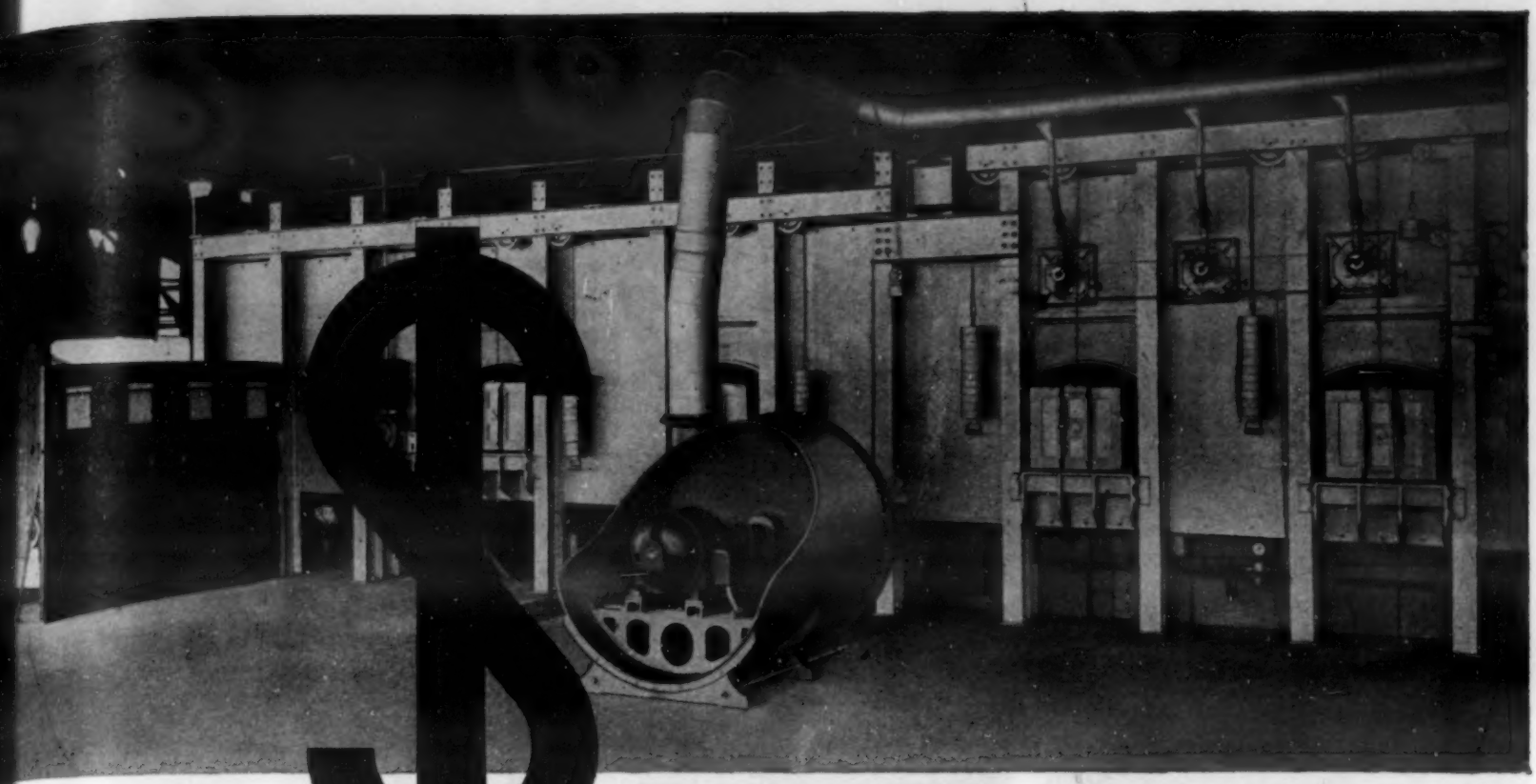
An all-purpose cutting electrode that pierces, gouges, chamfers or removes without the use of oxygen or special e ment has been announced by *Al Welding Alloys Co., Inc.*, 273 Ferris White Plains, N. Y.

Secret of the fast cutting and easy co which characterizes this electrode is a be a highly heat-resistant coating that centrates the arc at the tip. The elec can be operated on welding machine either the motor-generator or the a.c. former type.

Forming & Machining

Cutting Oil

A new, specialized cutting oil that bines the functions of rust prevention, cation and cooling for machining opera



$ OLLAR A YEAR MACHINES!

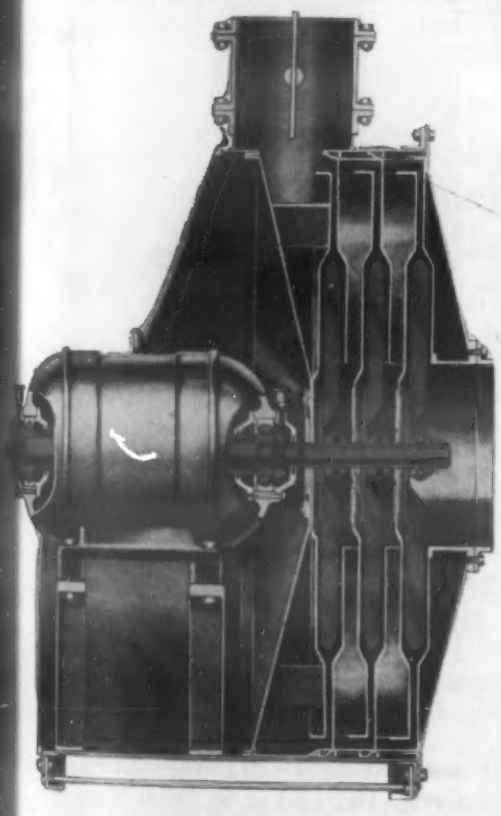
(SPENCER TURBO-COMPRESSORS)

A study of typical plants where Spencer Turbo-Compressors have been in use ten years or more shows less than one dollar per year per machine for spare parts.

The centrifugal design with wide clearances, low peripheral speeds and only two bearings to lubricate is partly responsible for this record.

Original test efficiencies are maintained for the life of the machine. Power is used only in proportion to the load—and efficiencies are high at all loads.

Spencer Turbos have been the preference in heat treating for many years. "Other uses" however have been increasing rapidly. Here are some of the special services that are being rendered by



SPENCER TURBOS

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Spencer Turbos are standard in capacities from 35 to 20,000 cu. ft.; ⅓ to 800 H.P.; 8 oz. to 10 lbs. Four bearing, gas tight; single and multi-stage.

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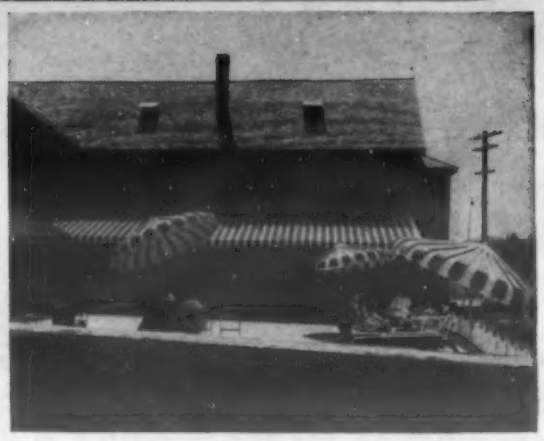
KOOL VENT VENTILATED ALUMINUM AWNINGS ARE *Alodized**

FOR EXTRA DURABILITY!

EXTRA PAINT PERMANENCE!



Modern, colorful KoolVent Awnings are designed for all-weather service in all seasons. That means these permanent, ventilated aluminum awnings must withstand the ravages of all elements and all foreign substances — sun, rain, snow, sleet, smoke, industrial fumes, dust, dirt, salt air, soapy water — so destructive to paint life

To provide the necessary paint-bonding and protective coating that meets the rigid service requirements of KoolVent Awnings, the manufacturers† of KoolVents use "Alodine" to anchor the paint finish and preserve its lustrous beauty.

METAL PROTECTED
Alodized
Durability Certified
"ALODINE" ANCHORS THE FINISH
American Chemical Paint Co.
AMBLER, PA.

*"Alodine"®

ALODIZED ALUMINUM provides enduring finish beauty and metal preservation. This fact, called to the attention of your customers by the attractive ALODINE seal, will give your products an extra selling point. The ALODINE seal is available to all qualified users of ALODINE. Details on request.

†KoolVent licensees using "Alodine" and/or Alodized aluminum include:

KoolVent Metal Awning Co. of Cleveland, Cleveland 15, Ohio
KoolVent Metal Awning Corp. of America, Texas Division, Dallas, Texas
KoolVent Metal Awning Co. of Pittsburgh, Glenshaw, Penna.
KoolVent Metal Awning Corp. of Michigan, Detroit 4, Michigan
Aluminum Awning Co. of Arizona, Phoenix, Arizona
KoolVent Aluminum Awning Co., Mercerville, New Jersey
KoolVent Metal Awning Corp. of Indiana, Pendleton, Indiana
KoolVent Metal Awning Corp. of Chicago, Elmwood Park 35, Illinois
KoolVent Aluminum Awning, Div. of Duralco Mfg. Co., Inc., Wheeling, West Virginia
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Eastern KoolVent Aluminum Awning Inc., Mineola, Long Island, N. Y.
KoolVent Aluminum Awning Co. of Arkansas, Inc., Little Rock, Arkansas
KoolVent Awnings Limited, Montreal, Quebec
KoolVent Metal Awning Corp. of N. E., Waltham 54, Mass.
KoolVent Metal Awning Co. of P.R., Inc., MacMurray & Co., Inc., Hato Rey, Puerto Rico
KoolVent of California, Inc., Los Angeles, California
Penn-Ohio KoolVent Metal Awning Corp., Girard, Ohio
Buffalo KoolVent Metal Awning Co., Inc., Buffalo 1, New York

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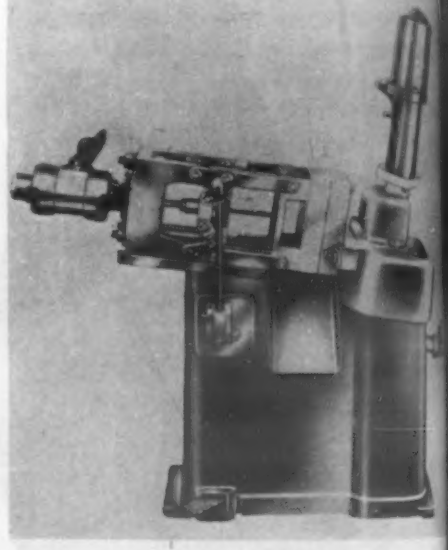
New Materials and Equipment

has been developed by *Turco Products*, 6135 South Central Ave., Los Angeles

Called Turco Cool-Cut, this versatile is said to deposit a light, rust-preven film on work and cutting tools. In addi it has a long tank life, does not cha color, separate, turn rancid or form gummy, carbonized film on work.

Small Die Casting Machine

Development of a low cost, comple air-operated die casting machine with matic injection of molten metal and matic opening and closing has been



Used for "on the spot" die casting, machine is said to allow substantial tion in costs.

nounced by *DCMT Die Casting Mach Corp.*, 164 Duane St., New York 13.

Designed and built to enable manufa turers to die cast small parts in their o shop, this machine is said to take jobs to one pound in capacity and to utilize blocks as thick as 2½ in. and as large 9 by 9 in. Production speeds as high as to 800 shots per hr. are possible.

Plastic Molding Press

Introduction of a high speed, semi-a matic, air operated platen-type press, to be designed especially to meet the quirements of molders of Plaskon al resins, has been announced by the *Hann Corp.*, 1141 S. Kilbourn Ave., Chicago

Designed to close fast, but gently,

I-T-E removes oil, dirt, sand and filings . . . easily and quickly . . . with

VAPOR DEGREASING

Large circuit breaker housings are clean and dry—ready for further handling—after vapor degreasing.

Speedy, trouble-free cleaning of a wide range of brass, copper, bronze, iron and steel parts . . . that's the 12-year performance record of vapor degreasing with trichlorethylene at the Philadelphia plant of the I-T-E Circuit Breaker Company.

All stampings thoroughly cleaned.

The springs, nuts, bolts, washers, switch parts and housings I-T-E manufactures for its circuit breakers and switch gears must be thoroughly cleaned before finishing and inspection, and after burring and sanding. To do this job simply and economically, I-T-E uses three vapor degreasers, one of which has been in service since 1937. These units deliver the parts clean, warm, and dry . . . ready for inspection or further processing.

This modern method of cleaning has fitted in perfectly with the high-speed flow of production at I-T-E. For your plant, too, the installation of vapor degreasing may mean increased production and lower costs in metal cleaning.

USE DU PONT TRICHLORETHYLENE DEGREASING SOLVENT

Thousands of manufacturers are using Du Pont Trichlorethylene for vapor degreasing.

Under various trade marks, Du Pont degreasing solvents have been widely used for many years. These solvents are stable . . . the best yet developed by Du Pont for metal degreasing. They stand up against contaminating and destructive materials which may be introduced in degreasing . . . assist materially in carrying out efficient cleaning.

non-flammable
DU PONT SOLVENTS for VAPOR DEGREASING

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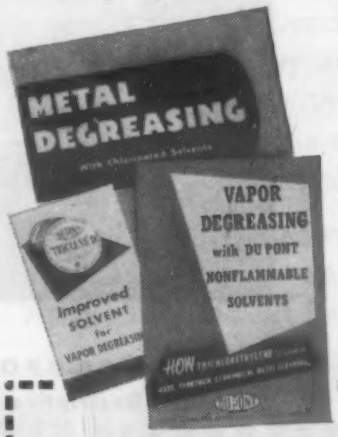

These three booklets will give you detailed information on the advantages of vapor degreasing, the equipment, industrial applications, and the Du Pont degreasing solvents.

Mail the coupon today!

E. I. du Pont de Nemours & Co. (Inc.)
Electrochemicals Dept., Wilmington 98, Del.

Please send me your free literature covering the vapor degreasing process and solvents. We are interested in cleaning _____ products.

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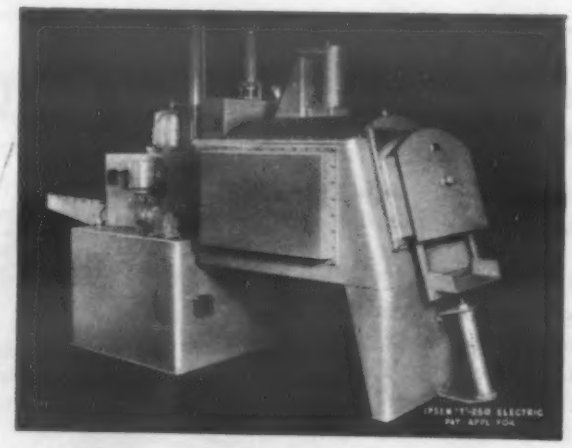

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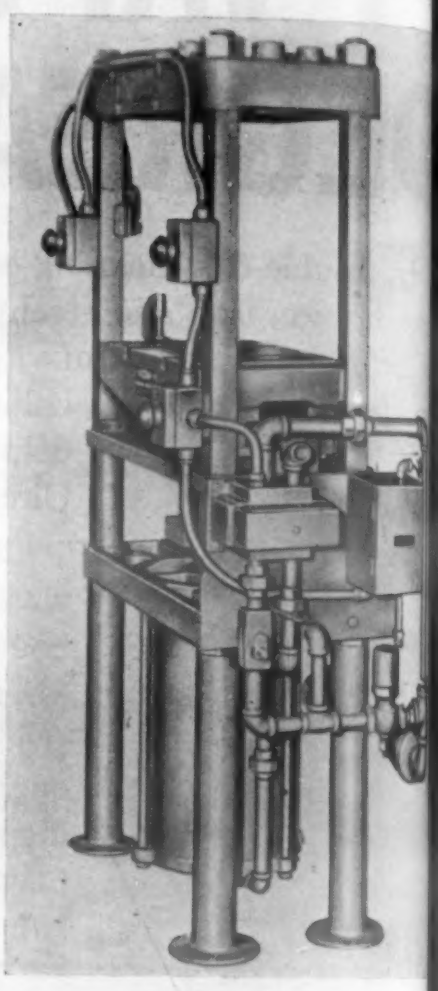
500 N. MADISON STREET • ROCKFORD, ILLINOIS

press is compact and self-contained and justable to 2-sec. speed, with special trolled deceleration of the platen a



Molders of Plaskon alkyd resins will this platen-type press especially useful

instant of closing to permit accurate ing of delicate parts. Completely adjust for speed, cycle and timing desired, the can develop 15 tons output force with psi. air supply.

Automatic Electron Drill

Development of a drill which approx or equals twist drilling speeds has b announced by *Elox Corp.* of Michigan, N. Rochester Rd., Clawson, Mich.

Employing new electronic principles operation, this motor-driven hard m drilling machine is said to use only 1/5 usual power while increasing the cut speed for hardened steels as much as times above previous Elox models. Pro tion cutting of extremely small as well large holes in hardened metals and pro tion removal of taps, drills and reamers only a few of the many applications claim for the fully-automatic Electron Drill.

Using the ⅛ in. optimum size electr

CHROMALOX

STRIP HEATERS

solve hundreds of heating problems

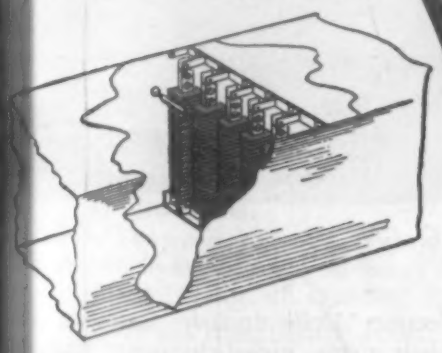
In straight lengths, curves, rings, segments and with fins. 4½" to 95" lengths; ¾" to 2½" width. Iron, steel and alloy sheaths.

efficient · dependable · low cost

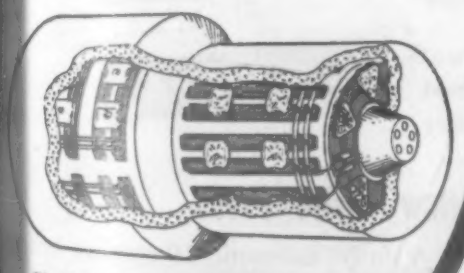
electric

heat for Processes and products

TYPICAL APPLICATIONS



Chromalox Electric Fin-Strip Heaters mounted in air ducts.



Plastic extrusion barrel with Chromalox Ring, Straight and Curved Strip Heaters.

IC-80

Easy to Install CHROMALOX Electric Strip Heaters give clean, dependable and accurately controlled heat. They are widely used in platens, dies, kettles, tanks, ovens, air ducts and other applications requiring accurate temperature control and around-the-clock service.

If you are a user of heat, either in processes or products, you can get many valuable application ideas by sending for the booklet below. On-the-job engineering assistance, without obligation.

CHROMALOX

Electric Heat for Modern Industry

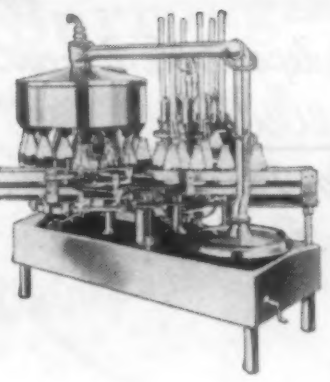
WANT MORE FACTS?

Send for this booklet of application ideas you can adapt for use in your plant. Write for your free copy today.

EDWIN L. WIEGAND COMPANY. 7523 THOMAS BLVD. · PITTSBURGH 8, PA.

MICROCASTINGS
Cut Cost 60%
ELIMINATE POROSITY • MACHINING

Microcast Parts are Smooth, Uniform, Sound as Cast



This small component used in milk bottling equipment was produced by Microcast... effecting a 60% saving over the previous method of manufacture.

MICROCAST is the answer to many design and production problems of small components.

Microcastings, as cast, are structurally sound, dimensionally uniform, and cast to such close tolerances that little or no machining is needed. Intricate shapes can now be specified in such extremely hard, non-machineable, non-forgeable alloys as stainless steel, tool steel, Stellite, and others.

complete and experienced technical service is always available to you at Microcast. Why not take full advantage of these facilities from the very beginning of your design problems... when maximum savings can be assured? Write for details of this service.

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224 E. 39th St., New York 16, N. Y.
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MICROCAST PRECISION CASTINGS PROCESS

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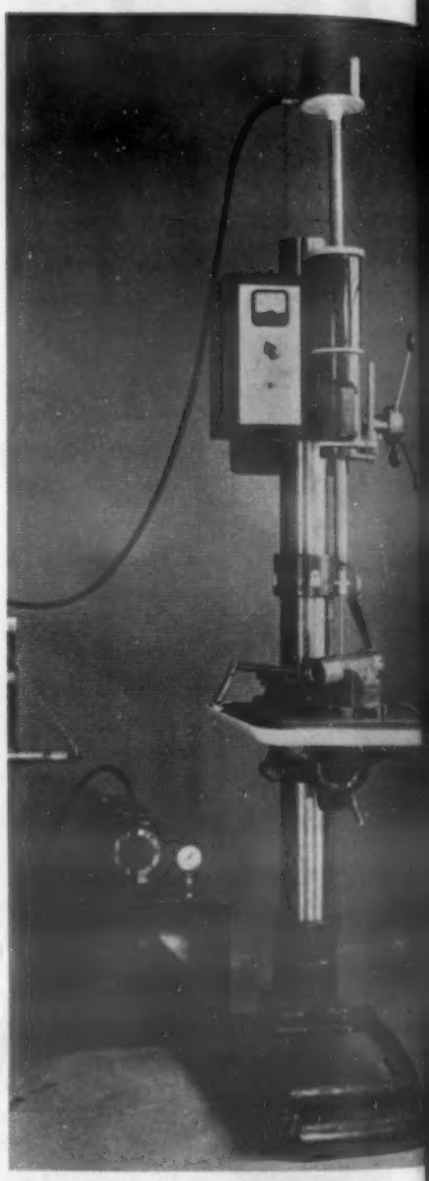
FREE BOOKLET
Fully illustrated 16-page booklet, complete with many applications, tells step-by-step explanation of Microcast Process. Write for your copy TODAY!

MICROCAST

New Materials and Equipment

the drilling machine requires 25 sec. ¼ in. hole, 60 sec. for a ½ in. hole 140 sec. for a 1 in. hole.

Materials which can be drilled by



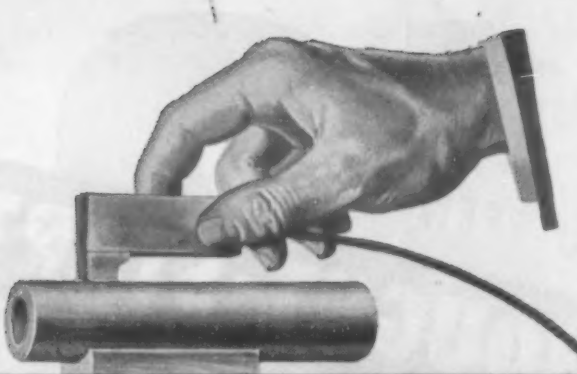
This fully-automatic Electron Drill is de to equal or approach twist drilling sp

Electron Drill include Carboloy, m cobalt steels, nickel-chromium steels, ganese steels, Stellite, cast iron, copper copper alloys, aluminum, Alnico, lead zinc.

New Plastics Press

A fully automatic 10-opening hydr platen press for precision polishing laminating of plastic sheets has been veloped by *R. D. Wood Co.*, Public Le Bldg., Philadelphia 5. Repetitive produ of exactly uniform sheets 0.003 to 0.75 thick and precise as to thickness, flexib

TO THE NAKED EYE...



...TO THE PROFILOMETER

Better Surface Finish

WITH ROCKRITE TUBING

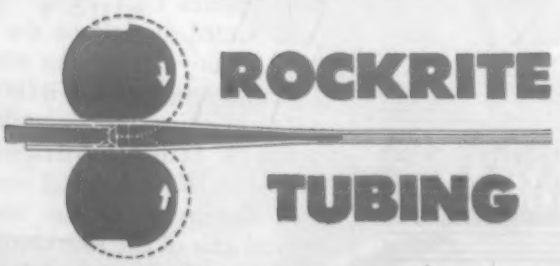
Here's why! The grain structure of the metal in Rockrite Tubing is finer, more uniform because the tube is sized under *compression* instead of by conventional sizing under tension.

How you save — Rockrite's *better surface finish* often eliminates the need for an additional finish cut. It also reduces grinding and polishing operations in many applications.

What's more, lighter close-tolerance Rockrite Tubing permits higher cutting speeds and substantially lowers over-all machining costs.

QUICK QUIZ —**What are the *three* requirements essential to tube accuracy and lower cost machined parts?**

ANSWER —**You'll find it in the new 16-page illustrated Rockrite Bulletin. Send for your copy today.**



Rockrite Saves More Than Any Other Tubing

- **Higher cutting speeds**
- **Tools last longer between grinds**
- **Work-surface finishes are better**
- **Machined parts have closer tolerances**
- **Stations on automatics are often released for additional operations**
- **Extra-long pieces available—less downtime for magazine stocking and fewer scrap ends**
- **Closer tolerances often eliminate necessity for machining on outside or inside**

TR-117

TUBE REDUCING CORPORATION · WALLINGTON, NEW JERSEY

HAVE YOU SEEN THESE

12 THOUGHT-STARTERS?

for better designs with

ACE MOLDED HARD RUBBER

HERE'S an "idea kit" guaranteed to stir your imagination and give you a hat full of hints for improving your products with strong, durable, corrosion-resistant, and electrically excellent Ace Hard Rubber. Yes, a few of the newer Ace plastics are included, too.

The kit shows how every property of hard rubber can be used to best advantage. It demonstrates cost-saving hints in molding, and shows a wide variety of design techniques, including inserts, shrink fits, machined parts, extruded parts, parts that are blown like glass bottles, etc.

Our sales engineer in your territory will be happy to spread these ideas out on your desk at the drop of a postcard. If you have a particular problem in mind, mention it. Chances are we've done something similar in our 98 years and can bring a sample of *that* along, too. *Write today.*

Have you a copy of the Ace Hard Rubber & Plastics Handbook? If not, just ask.

ACE

HARD RUBBER and PLASTICS

AMERICAN HARD RUBBER COMPANY

Since 1851

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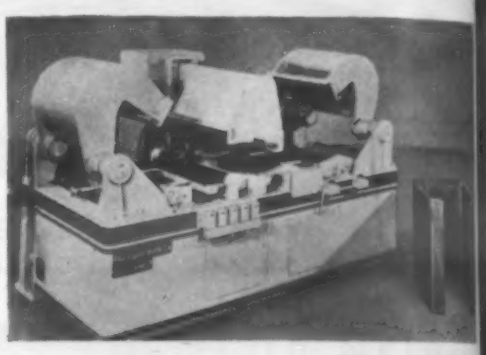
New Materials and Equipment

and coloring is claimed by the manufacturer. The press can be built in a wide range of sizes for varying pressures.

New Bending Machine

A new bending machine, designed to form outer cases for automatic washing machines, has been developed by the *Cyril Bath Co.*, 6901 Machinery Ave., Cleveland 3. Known as the Four-Wing Tangent



This unusual looking machine forms outer cases for automatic washing machines.

Bender it completely forms the rectangular-shaped cases at the rate of 125 per hr through a sequence of fifteen automatically controlled operations.

This forming method makes it possible to produce the complete, wrap-around case in one piece, ordinarily impossible on heavy presses using conventional and more costly male and female dies.

•

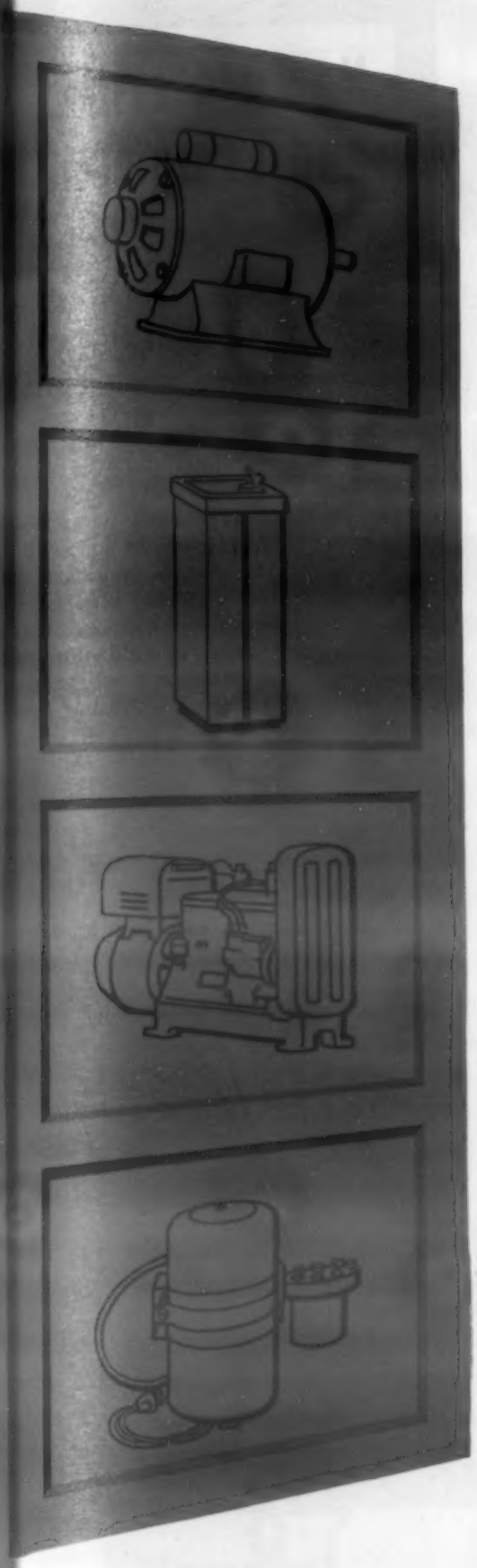
Testing & Control

Hardness Indenter

A hardness indenter which attaches interchangeably with the objectives of conventional type microscopes is being manufactured by *Erb & Gray*, 854 S. Figueroa St., Los Angeles 17.

Mounted directly on the microscope body tube or on a revolving nosepiece, the MH Indenter employs a Vickers 136° diamond pyramid point fixed in a drum which moves vertically against low-friction sapphire bearings. External centering screws permit positive alignment of the indenter with the optical axis of the microscope.

(Continued on page 116)



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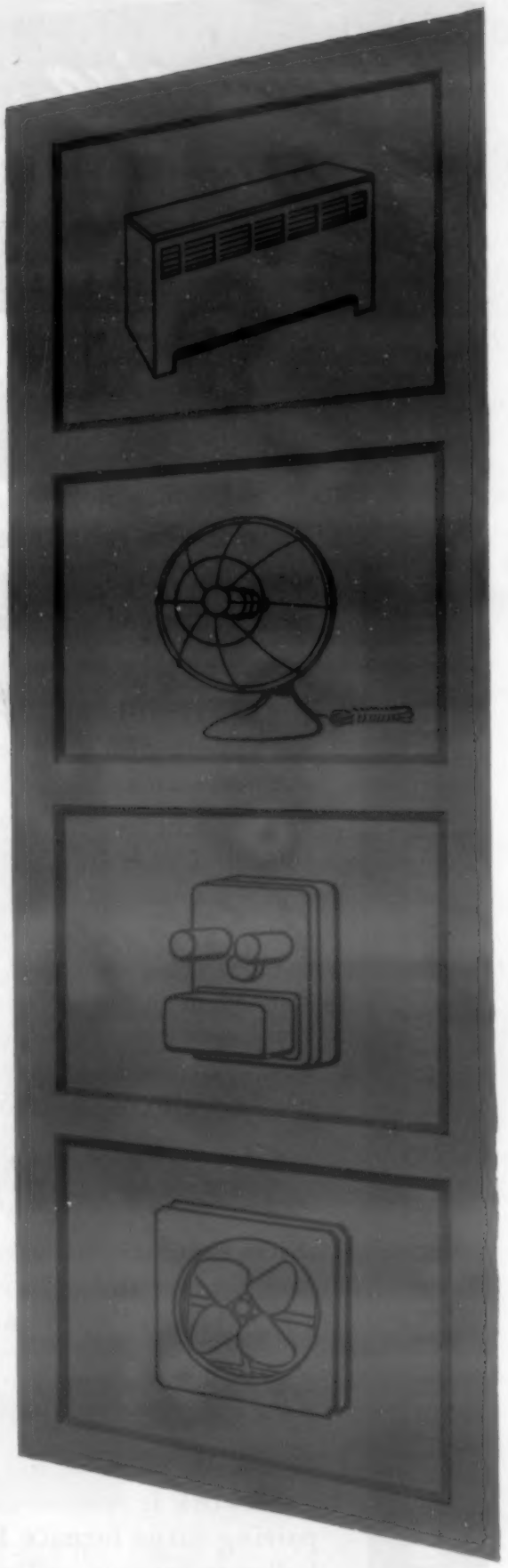
YOUR BEST METAL CHOICE IS

HUSSEY

COPPER AND BRASS

Electrical conductivity . . . corrosion resistance . . . thermal conductivity . . . lifetime beauty — if your electrical products require one or more of these characteristics . . . your best metal choice is Hussey Copper or Brass. In your product, Hussey Copper assures versatile physical properties plus extreme ease and speed in forming and fabrication. Seven complete warehouses place Hussey Copper and Brass within easy range of your production.



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Announcing...
2 more **BLAZECRETE®**
Hydraulic-setting
REFRACTORIES

These 2 new refractories, with the famous 3X Blazecrete, cover the range of industrial requirements for new furnace construction and many maintenance uses.

To team up with the highly successful 3X BLAZECRETE Johns-Manville has developed these 2 new refractories with many similar characteristics but designed for lower temperature applications. Like 3X Blazecrete they too, can be flipped into place and troweled smooth without ramming or tamping . . . or can be gunned.

1. Standard **BLAZECRETE** (2000 F TO 2400 F)

For building and repairing old refractory linings. Makes brick work repair easier and less costly than using "Plastics." For use by boiler manufacturers to replace fire clay tile in wall construction. Does not require prefiring.

2. L.W. **BLAZECRETE** (2000 F)

A low conductivity refractory concrete for use in building new linings and repairing old. Its light weight makes it adaptable and economical for many applications.

Now famous **3X BLAZECRETE** (3000 F)

Unusually effective for heavy patching, especially where brickwork is spalled or deeply eroded. Excellent for repairing forge furnace linings, burner blocks and lining ladles in ferrous and non-ferrous foundries.

• • •

Blazecrete products harden after only 6 hours of air curing . . . can then be fired or left standing indefinitely. Come dry in 100-lb. bags. Unmixed portions can be stored for future use. Approximately 130 lb. per cu. ft. of each is needed for slap-troweling; 155-lb. per cu. ft. for gunning. Write Johns-Manville, Box 290, N. Y. 16, N. Y.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville
BLAZECRETE REFRACTORIES
for patching and gunning

New Materials and Equipment

Following indentation, the indenter is replaced by the viewing objective, and measurements of the indentation diagonals are made with a Filar screw micrometer eyepiece. Measurement is directly convertible to Standard Vickers Numbers, for which a conversion chart is supplied. Some typical applications listed include the following:

Hardness testing of small parts, wire, thin sheets, foils, razor blading; nitrided, carburized, decarburized and diffusion areas in steels; localized areas of cold work; and identification and hardness measurements of such materials as bearing alloys, cast metals, hard facing alloys, electroplated coatings and mineralogical specimens.

Sonic Comparator

Grade, soundness and homogeneity of abrasive wheels, sticks, segments and tiles can be tested, under extremely rapid production conditions by the Sonic Comparator

This Sonic Comparator reveals small differences in physical characteristics.

recently developed by the *Saturn Electronics Co.*, Niagara Falls, N. Y.

Measuring the natural period and amplitude of vibration of the body under test as related to the natural period and amplitude for a standard body known to have the desired physical properties, requires but from 10 to 15 sec. per article. Other applications are said to include research or production testing of many different types of ceramic

ROLOCK

FABRICATED HEAT AND CORROSION RESISTANT ALLOYS

Visit us at Booth No. 522, Metal Show, Chicago, week of October 23rd.

Photograph shows fire-flash at instant basket and load contacted the quench.

. . . just about the toughest shock for *any* basket. But Rolock fabricated-welded Pit Type Furnace Baskets now standardized at the Peck, Stow & Wilcox plant, Southington, Conn., are showing fine performance records in gas carburizing.

Their department head says, "Very satisfactory, not only in view of severe conditions, but also because they eliminate rough work handling from furnace to quench, which previously caused excessive distortion."

DETAILS: Baskets Inconel frame and cloth, 20" dia. x 11"; weight 45 lbs.; load 225 lbs. (hand tool parts); furnace temperature 1650° F.; oil quench (100° F.); ratio live-dead load 5 to 1; basket life 2 years. Furnace load 3 baskets.

ADVANTAGES: Light weight, greater furnace capacity, easier handling, uniform quench (wire cloth sides) providing complete case depth uniformity, minimum dragout loss of quench medium, lower costs.

Rolock engineers are cutting heat-hour costs and improving product quality. May we do so for you? Write for catalog.

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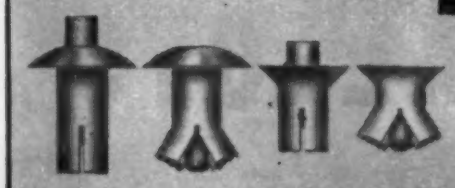
ROLOCK INC. • 1282 KINGS HIGHWAY, FAIRFIELD, CONN.

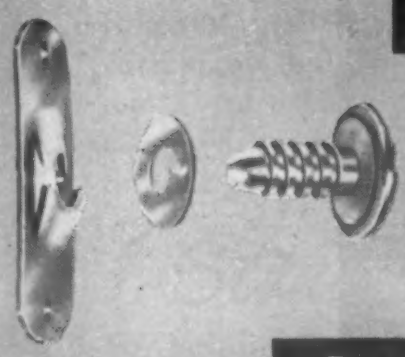
JOB-ENGINEERED for better work
Easier Operation, Lower Cost

a better fastening job at lower installed cost



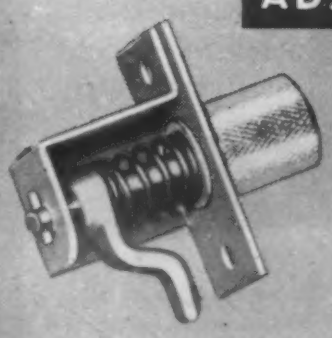
SOUTHCO DRIVE RIVETS

Industry's tested hammer-driven Blind Rivet. No bucking, trimming or finishing—no special tools. Driving pin from one side of job expands prongs—pulls sheets together tightly and permanently.



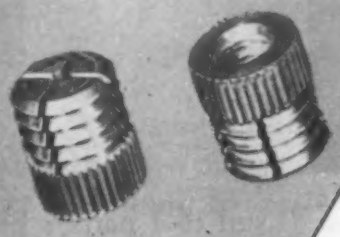
SCREW TYPE FASTENERS

For removable panels, access doors, etc. One screw length holds panels of varying thickness under uniform tension. Fast, easy to install—no inventory problem. Available in two size ranges.



ADJUSTABLE PAWL FASTENERS

Same fastener fits all door thicknesses—merely drill 3 holes—install 2 rivets. Spring tension can be adjusted to form dust seal. Handy single unit. Ideal when frequent access is desired.



SOUTHCO ANCHOR NUTS

For blind fastening to plywood and decorative laminates **without disfiguring surfaces.** Install SOUTHCO Anchor Nuts as permanent base for removable machine screws. Can't twist or tear out.

Write today for information on complete line of

SOUTHCO FASTENING SPECIALTIES

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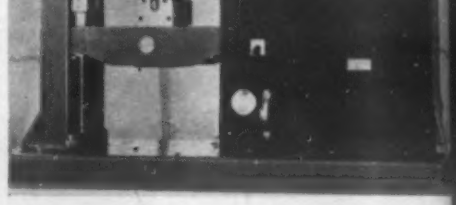
New Materials and Equipment

plastic and metallic materials, as ... physical differences affect vibration cha... teristics considerably.

Universal Testing Machine

A simplified Table Model Universal Te... ing Machine for tension, compression, fl... ure, shear and transverse tests is now av... able from the *National Forge & Ordn... Co.*, Irvine, Pa. in two capacities: 30,0... and 15,000 lb. Additional ranges of 6... and 6000 lb. are included in the 30,000... model while the 15,000 lb. model may ... used for 300 or 3000 lb.

Crosshead speeds are said to be infini...



This Table Model Universal Testing M... chine has crosshead speeds infinitely vari... from 0.005 to 6 in. per min.

variable from 0.005 to 6 in. per min. w... a crosshead stroke of 14 in. operating i... 20 in. working space between colum... Furnished with gear-operated wedge gr... the unit can be equipped with holders f... threaded specimens and fixtures for mak... compression, flexure and shear tests.

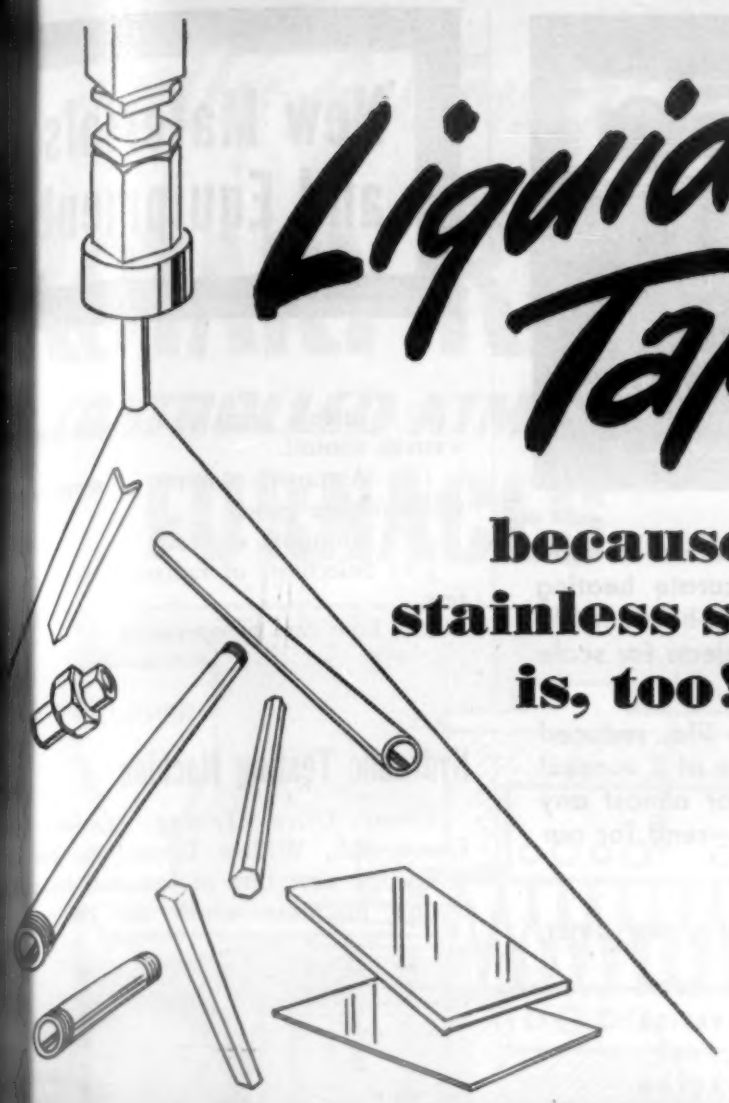
Weathering Tester

Accelerated weathering tests can be ma... with a new automatic tester produced ... *Hanovia Chemical & Manufacturing Co.*, 100 Chestnut St., Newark 5, N. J.

Called the Climatron, the instrument ... said to offer rapid and dependable det... mination of the light fastness and weathe... ing resistance of specimens exposed to ... Simulated sunshine, temperature, humid... and rain can be regulated by the setting ... a time cycle meter and a thermo-regula... so that the entire testing cycle is operat... automatically.

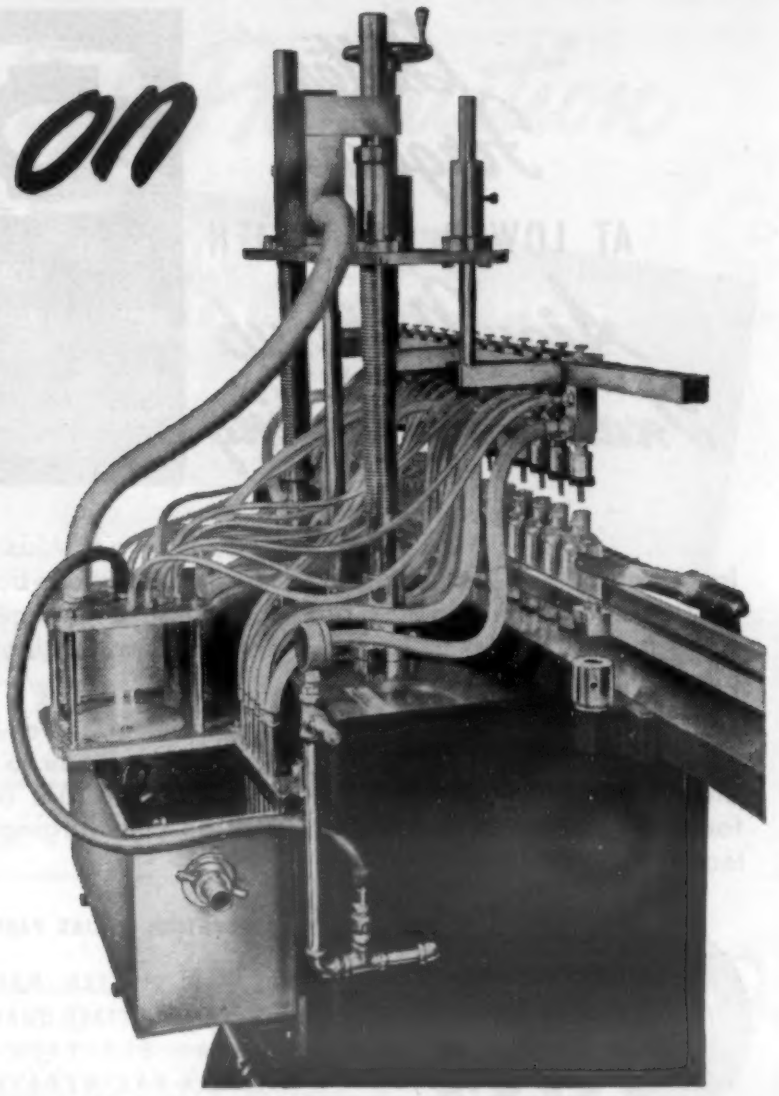
Engineering features of the Climatron ... clude:

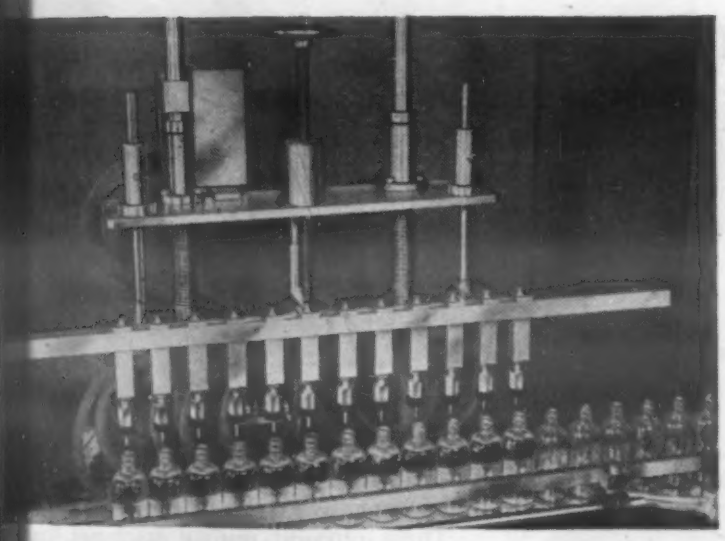
(1) Compact, self-contained, mobile un...



Liquids on Tap

because stainless steel is, too!





Chemical, cosmetic, and other manufacturers are now using this ingenious, all-stainless filling machine for high speed precision packaging of their liquid products.

It fills containers with any type of fluid—free flowing, viscous, or foaming—through a battery of automatic valves actuated by a single foot pedal operation.

The nature of each liquid to be filled requires that every machine be custom built, normally a headache in materials procurement. The illustrated machine, for instance, uses stainless steel nipples, unions, plates, sheets, angles, rounds, flats, squares, hexes, screws, nuts, seamless tube, and pipe.

The manufacturer of this unit, however, has simplified his problem by standardizing on stainless steels from Frasse warehouse . . . and by relying for selection of the correct types on Frasse engineering service. In just the quantities and exactly the analyses needed, he gets his requirements immediately from Frasse stocks.

You're invited, too, to make Frasse your inventory headquarters for stainless steel. Frasse stainless stocks include every rolled form . . . sheets, strip, bars, tubes, pipe, and specialties . . . in a wide range of sizes and analyses. *For immediate stainless service, call Peter A. FRASSE and Co., Inc., 17 Grand St., New York 13, N.Y. (Walker 5-2200) • 3911 Wissahickon Ave., Philadelphia 29, Pa. (Baldwin 9-9900) • 50 Exchange St., Buffalo 3, N.Y. (Washington 2000) • 157 Richmond Ave., Syracuse 4, N.Y. (Syracuse 3-4123) • Jersey City • Hartford • Rochester • Baltimore*

FRASSE *for* **STAINLESS STEELS AND TUBING**

COURTESY OF PERL MACHINE MFG. CO.

Write for NEW DATA on E. L. C. STAINLESS STEELS

A new Frasse Engineering Memorandum on the "Resistance to Sensitization of Extra Low Carbon Stainless Steels" is now available. Shows results of comparative tests on types 302, 304, 316, 321, 347, and 304 ELC for corrosion immunity after welding. Send the coupon for your free copy, today.

PETER A. FRASSE & CO., INC. 58L
17 Grand Street, New York 13, N. Y.

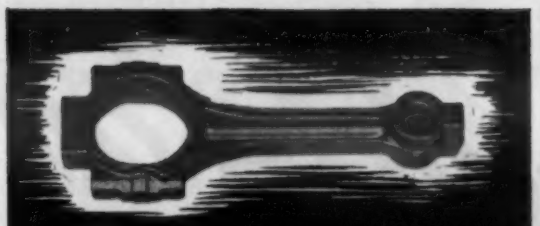
Please send me a complimentary copy of your Memorandum No. 5 on ELC Stainless Steels.

NAME_____ TITLE_____

FIRM_____

ADDRESS_____

Better Forgings AT LOWER COST WITH Ajax-Northrup Induction Heating



CONNECTING RODS
Production: 400 per hour
(capacity 600 per hour)
Stock: 1½" x 12¾" r.c. squares, A-1335 steel.
Heaters: Bank of four Ajax-Northrup induction heaters at 450 kw.

Switching to Ajax-Northrup induction heating made these connecting rod forgings *better*—because accurate heating control and elimination of scale permitted a change from drop-hammers to press forging. Better metal flow, more uniform forgings, fewer rejects for scale pits or dimensional inaccuracy.

Costs were lowered, too. No loss of steel in scale, longer die life, reduced machining cost because the forgings could be made to a tolerance of 2 *ounces!* Clean, fast, economical Ajax-Northrup heaters are available for almost any forging application. Put them to work on your forging problems—send for our technical bulletins today.

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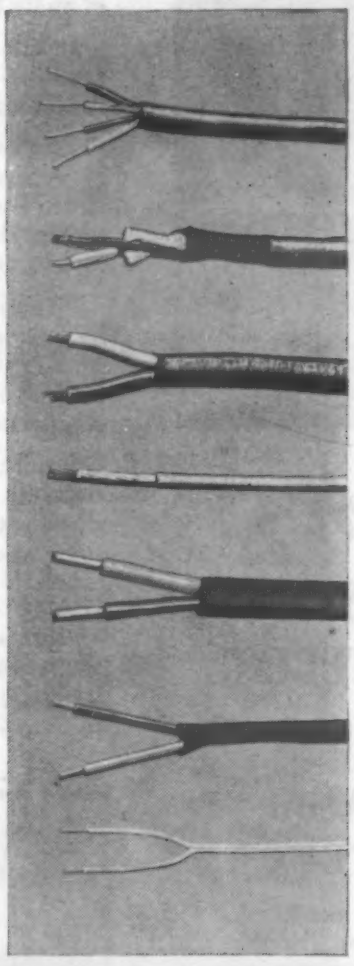
AJAX ENGINEERING CORPORATION

AJAX NORTHRUP

HEATING & MELTING

DEPENDABLE LINKS between Thermocouple and Pyrometer



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Made only of carefully selected materials—accurately calibrated to exacting limits and insulated to meet the varying demands of industry.

When your temperature measuring application requires Lead Wire that will withstand extreme temperature, that is moisture and abrasion resistant, there is a Thermo Electric Wire for you. — Regular and "AN" Types made for all standard calibrations — Iron Constantan, Copper Constantan and Chromel Alumel.

Be sure of accurate temperature readings — install dependable Lead Wires, Thermocouples and Accessories.

For Complete Lead Wire Specifications, Write for Wire Section 30G.

Thermo Electric CO., INC.
FAIR LAWN NEW JERSEY

New Materials and Equipment

(2) Intense light source with co wattage control.
(3) Automatic control of tempera and moisture cycle.
(4) Humidity control.
(5) Selectivity of radiations through ters.
(6) Low cost of operation.

Hydraulic Testing Machine

Tinius Olsen Testing Machine Easton Rd., Willow Grove, Pa. has veloped a new line of low cost hydr testing machines which are claimed

Low cost, versatility, and easy operati feature this new hydraulic testing machi

provide many features not incorporated more expensive types of similar equipm

These physical testing machines, nam the Olsen Super L Type, can be used f tension, compression transverse and flex testing. Equipped with the new Ol Selec-TO-range indicating system, they p sess a 50 to 1 spread of testing ranges, s to be unique in a low cost universal testi machine.

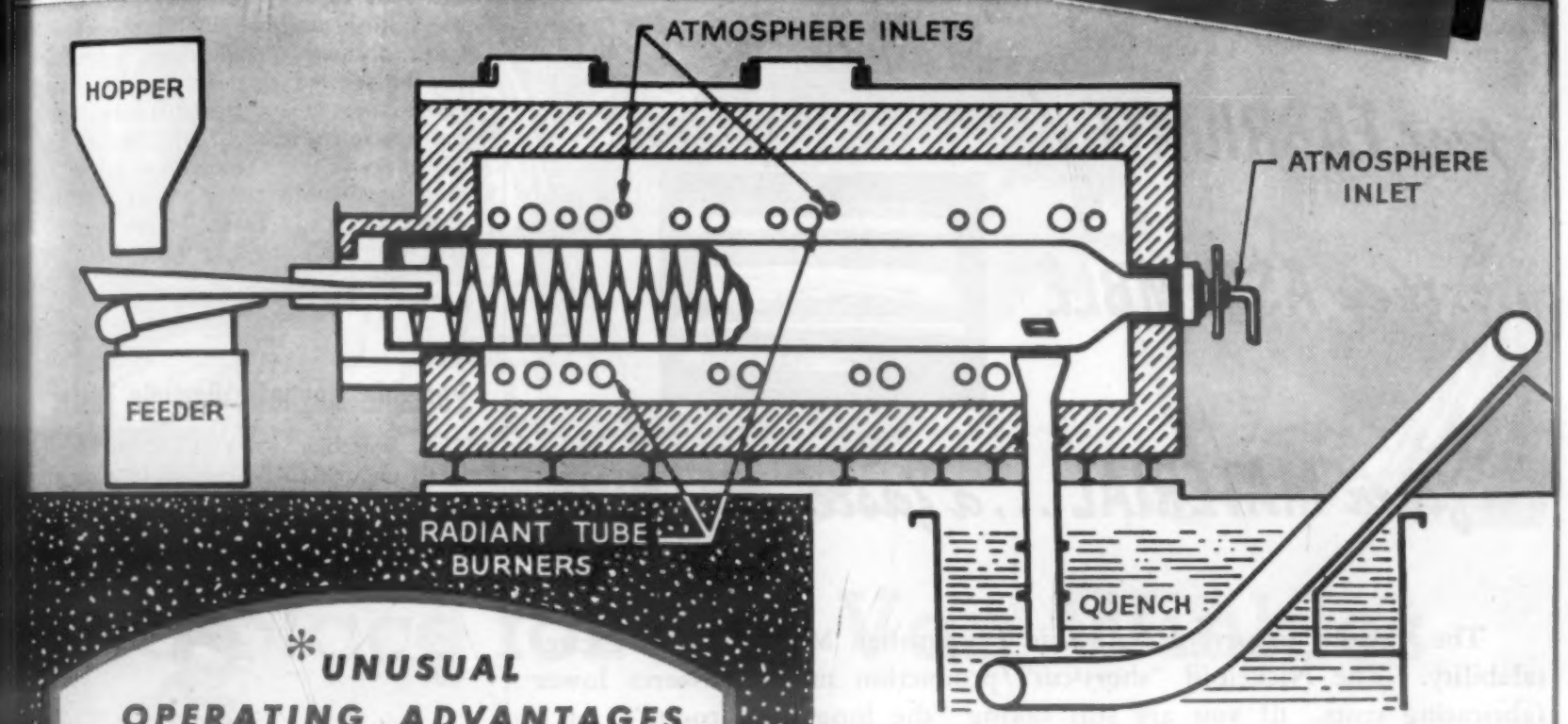
As an example of the machine's ver tility, the 60,000 lb. Super L model h 100 lb. graduations on its top range a 20 and 2 lb. divisions on its 12,000 a 1200 lb. ranges, respectively. The lo range in use is automatically illuminat on the 28 in. dia. indicator dial, showi capacity and the value of dial division characteristic colors, making identificati simple for inexperienced and unskill workers. In addition, each capacity is pr vided with automatic overload prevent controls.

Since the zero load of all three ranges identical, test ranges can be changed wi out changing the rate of loading during test—especially valuable when testing spe

Fully Automatic—High Production

ROTARY RETORT
CONTROLLED ATMOSPHERE FURNACES*

FOR MODERN HEAT TREATMENT INCLUDING:
Gas Carburizing
Dry (gas) Cyaniding
Homogeneous Carburization
and Clean Hardening



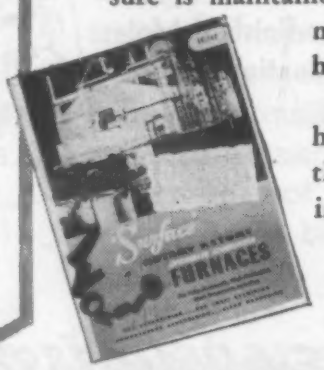
A 'Surface' Rotary Retort Furnace is equipped with one or more cast alloy retorts, each provided with an internal screw thread. The retorts are operated with an oscillating type of motion which is gentle and non-abrasive and accomplishes a forward movement of the metal pieces through the retort.

*UNUSUAL OPERATING ADVANTAGES

1. Improved and uniform contact of metal pieces with the prepared gas atmosphere, as compared with other types of work handling.
2. High thermal efficiency. No trays or fixtures to heat or cool.
3. Fully automatic operation possible . . . minimun of manual handling. Low maintenance costs.
4. Especially adaptable to limited production by control of rotation cycle and/or charging rate.
5. 'Surface' RX Gas Atmosphere Generator supplies atmosphere gas for all modern heat treatments.

● 'Surface' Rotary Retort Furnaces are the first successful units of their kind because a protective atmosphere is utilized within the heating chamber as well as the rotary retort. A positive pressure is maintained within both areas, thereby protecting the metal from outside air contamination during heat treating and quenching.

These units provide unusually high quality heat treatment. Capital investment about 40% that of equivalent pusher-type furnace. Minimum space required for high production.



◀ *Complete details are given in Bulletin SC-147. Write for your copy today!*

SURFACE COMBUSTION CORPORATION • TOLEDO 1, OHIO

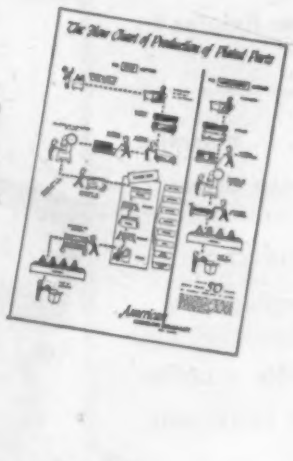
FOREIGN AFFILIATES:
Stein & Roubaix, Paris — *British Furnaces, Ltd., Chesterfield*

'Surface' **INDUSTRIAL FURNACES**

FOR: Gas Carburizing and Carbon Restoration (Skin Recovery), Homogeneous Carburization, Clean and Bright Atmosphere Hardening, Bright Gas-Normalizing and Annealing, Dry (Gas) Cyaniding, Bright Super-Fast Gas Quenching, Atmosphere Malleableizing and Atmosphere Forging. Gas Atmosphere Generators.

The lustrous beauty of Nickeloid Pre-finished Metals assures greater salability. The Nickeloid "short-cut" production method assures lower fabricating costs. If you are still taking "the long way 'round", let a Nickeloid Sales Engineer show you the "short-cut".

Nickeloid Metals are available in sheets or coils, in a wide range of gauges and tempers, plated one or two sides, bright or satin finishes of Chromium, Nickel, Brass, or Copper, plated to base metals such as Steel, Zinc, Brass, Copper or Aluminum.



Write for new "Flow-Chart" showing how Nickeloid Pre-finished Metals eliminate costly production operations.

NICKELOID METALS (Pre-Plated)
NICKEL · CHROMIUM · BRASS · COPPER
Electro-plated TO ALL COMMON *Base* METALS
ALSO LACQUERED COLORS
SHEETS AND COILS
OLDEST AND LARGEST PRODUCERS OF PRE-PLATED METALS

Established 1898
AMERICAN NICKELOID COMPANY
PERU 6, ILLINOIS

New Materials and Equipment

mens which exhibit higher physical valu
than anticipated.

An additional feature of these machin
is the Olsen Electronic Stress-Strain R
corder which produces strain magnificatio
from 10 to 1000. With the recorder, fu
and half capacity for each load range
the testing machine can be plotted as t
stress ordinate. Furthermore, other rang
can be secured by resetting the recordi
pen to start at any particular lead point
the specimen under test. This is said
make possible the accurate study of spe
men stress-strain behavior not only in t
elastic and early plastic stages, but in a
selected plastic stage as well.

Portable Magnetic Particle Tester

A portable, low-cost Magnaflux un
small enough to be carried in a car trun
has been announced by the *Magnaflu
Corp.*, 5900 Northwest Highway, Chica
31. Called the KH-05 and designed, li

*Magnetizing cables can be easily connect
and looped with the KH-05 portable Mag
naflux unit.*

other Magnaflux units, to detect invisib
fatigue cracks, shrink and weld cracks, et
this unit requires only 110 volt a.c. supp
lines to give a.c. or d.c. magnetization.

All operations are controlled by a sing
switch on an inclined control panel, whi
carries a meter that reads in true magnet
ing amperes and an indicator light whi
indicates when magnetizing current is avai

No place for Rip Van Winkles

TWENTY years bring changes--changes far greater in our fast-moving world than ever happened in Rip Van Winkle's day.

Americans are awakening to unpalatable facts--that the enterprise system which built our nation and made it strong is being subtly undermined; that advocates of backdoor socialism and communism thrive in our midst; most dangerous of all, that our young people are misinformed on economics.

For example, a recent survey of high school seniors reveals that they estimated that it takes only an $81 investment to provide a job. Actually, as shown by the 1947 census, the 2256 establishments of the iron and steel industry invested $545 per worker that year alone in *new* plant and equipment. Total investment to provide one job runs well above $10,000.

These youth had a similarly distorted picture of profits. They believe shareholders receive 24% of the sales dollar whereas they receive an average of less than 3%.

Misinformed minds are a ready field for imported false philosophies. And it is up to you, a business leader in your community, to take responsibility toward correcting these misunderstandings. The American businessman must not permit himself to be lost in Rip Van Winkle befuddlement.

THE YOUNGSTOWN SHEET & TUBE CO. 1900 YOUNGSTOWN 1950 50 YEARS OF SERVICE

The Youngstown Sheet and Tube Company

General Offices--Youngstown 1, Ohio

Export Offices--500 Fifth Avenue, New York

MANUFACTURERS OF CARBON ALLOY AND YOLOY STEELS

ELECTROLYTIC TIN PLATE • COKE TIN PLATE • WIRE • COLD FINISHED CARBON AND ALLOY BARS • PIPE AND TUBULAR PRODUCTS • CONDUIT • RODS • SHEETS • PLATES • BARS • RAILROAD TRACK SPIKES.

RUBATEX SEALS

—for pre-cast concrete wall panel joints provide these advantages:

- ***Resilient—even at low temperatures***
- ***Excellent insulation***
- ***Zero moisture absorption—weatherproof***
- ***Resists oxidation***

Most of the walls of the Columbia Cellulose Co., Ltd.'s new pulp plant in British Columbia are pre-cast concrete slabs. When the slabs are assembled, strips of RUBATEX Closed-Cell Rubber are used to seal the vertical joints.

The unique closed cell structure of RUBATEX is non-porous, making an efficient insulation. Inert nitrogen retained within the cells under pressure, provides high compressive strength and resiliency. RUBATEX resists oxidation and is rot and vermin proof.

If you have a gasketing, cushioning, shock-absorbing, or vibration damping problem, try RUBATEX. For most applications, RUBATEX can be economically cut from sheet stock. RUBATEX is available in natural and synthetic stocks and in soft, medium and firm forms. RUBATEX DIVISION will gladly provide engineering advice and assistance. For further information, write for Catalog RBS-12-49. Great American Industries, Inc., RUBATEX DIVISION, BEDFORD, VIRGINIA.

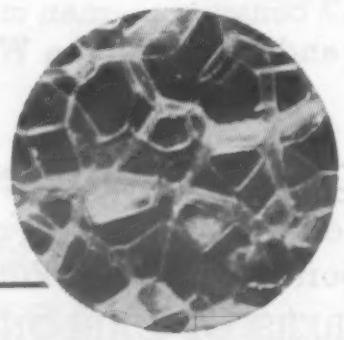


Photo-micrograph shows how each cell is completely sealed by a wall of rubber. The material cannot absorb moisture. It has high insulating values, is highly resistant to oxidation and is rot and vermin proof.

RUBATEX® CLOSED CELL RUBBER

New Materials and Equipment

able in the cable. At the job, the magneti ing cables can be connected as desired, bei equipped with Eitherend connectors, and th magnetizing coil easily looped around th part to be inspected or through openings i the part when necessary.

Portable Ultraviolet Tester

An ultraviolet device for the non-destru tive testing of structures, weldments, vesse and other objects too large for transport to permanently-installed black-light booth ha been developed by *Menlo Research Labo tory,* P. O. Box 522CU, Menlo Park, Cal

Weighing less than 2 lb., the Mer Fluoretor combines portability and self pow ered operation with facilities which are su to permit observation under the most in tense surrounding light.

Two standard size D flashlight batteri supply power for the ultraviolet generat which is attached by a swivel joint to th handle containing the power component A chamber fits around the generator head t exclude light from the area under examina tion, and is equipped with a sponge rubbe cone to improve the light seal on rough o irregular surfaces. Three times magnificati is provided by a focussing eyepiece.

Fatigue Testing Machine

What is said to be the first "constan force" fatigue machine designed with fu nace and control equipment for direct stre fatigue testing at elevated temperatures ha been announced by the *Baldwin Locomoti Works,* 950 Simpson St., Philadelphia 4

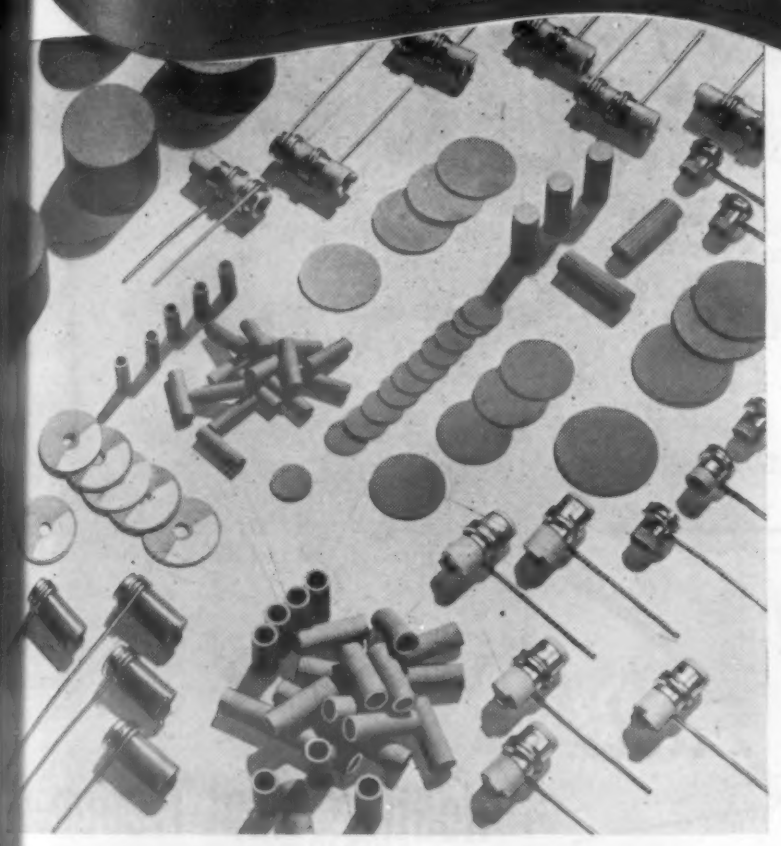
Designated the Sonntag Fatigue Machin Model SF4, it has a static preload that ca be varied steplessly from 0 to 8000 lb; dynamic load capacity of ±5000 lb. and maximum capacity in one direction o 13000 lb. During testing, the heating fur nace can be adjusted between room tem peratures and 1800 F, ±10F. Speed o testing is 3600 cycles per min.

Automatic Metal Sorter

An automatic metal sorter, which affor high speed, non-destructive quality contr and sorting of metal parts of any size

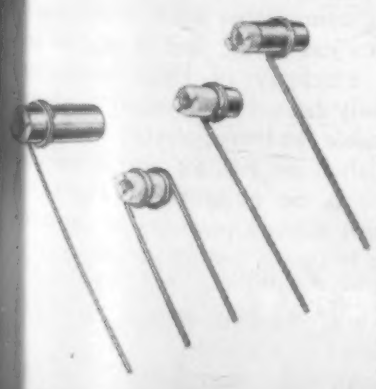
Stupakoff Ceramics

FOR ELECTRONIC APPLICATIONS



CERAMIC DIELECTRICS

Stupakoff makes a wide variety of CERAMIC DIELECTRICS as tubes, discs and special shapes, plain or silvered for temperature compensating capacities to reduce frequency drift in RF, TV and other circuits. Also, general purpose ceramic dielectrics for by-pass, lead-through blocking, stand-offs and trimmer applications, and temperature compensating ceramic dielectrics with coefficients from P-100 to N-2700 and high K materials up to K-6000.



STUPACITORS

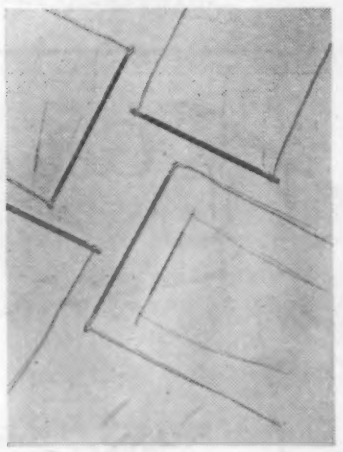
Two new Stupakoff electronic products are the STUPACITOR Trimmers and Stand-offs.

Stupacitor Trimmers are ideal for standard and temperature compensating capacitors, starting at 0.5 mmf. The stand-offs serve, in addition, as capacitors. Advantages are: low cost, neat, easy assembly, compact.

STUPALITH®

The ideal ceramic for *Extreme Thermal Shock*, Stupalith designates a group of ceramics which may be formulated and processed to possess zero, low positive and low negative expansitivities. Formed by conventional methods. May be machined or ground to precision tolerances. For temperatures up to 1200° C.

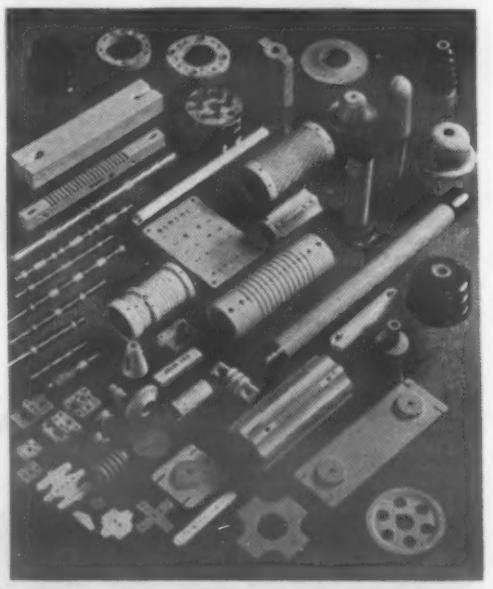
TEMPERATURE SENSITIVE RESISTORS



Made to exacting standards and specifications, Stupakoff Negative Temperature Coefficient Resistors are supplied complete with terminals in the form of rods, tubes and simple shapes, including discs, bars and washers. Sizes currently available in rods are .010" to .500" diameter. Tubes are from .020" to .500" O.D., with I.D. up to 75% of O.D. Resistance decreases approximately 3% for each degree C. temperature increase.

OTHER CERAMIC PARTS

Precision-made ceramics for all temperatures, voltages and frequencies—plain, metallized or assembled. Stupakoff offers exceptional engineering and manufacturing facilities for the design, application and production of highest quality ceramic parts.



STUPAKOFF CERAMIC & MANUFACTURING COMPANY

TELEPHONE: LATROBE 1400 — Latrobe, Pennsylvania — CABLE: STUPAKOFF LATROBE

SCHAEFER-HAUSER MOLDING CORP.
PRECISION MOLDERS
62 William Street, New York 5, N. Y.
Digby 4-0780

NEWS on NYLON Molding

Our new molding technique permits us to state unequivocally that:

1. Nylon parts cost less (often considerably less) than metallic components they replace in the majority of cases.
2. Die costs are not expensive.
3. Small runs are possible at a reasonable price.
4. Our prices on large runs are definitely competitive.

We offer the assistance of our research engineers to help solve your problems in connection with Nylon Molding.

If you are not now using Nylon, our product study service is available. Possibly we can show you how advantageous Nylon Molding can be with our methods and equipment.

SCHAEFER-HAUSER MOLDING CORP.

Send for this BROCHURE

Get all the Facts

A Brief Survey of TECHNICAL CHARACTERISTICS of MOLDED CERAMIC PRODUCTS

for Electrical Wiring, Electrical Heating, Special Applications

Prepared by the Technical Staff of the STAR PORCELAIN COMPANY, Trenton, N. J.

15-page illustrated booklet describes a wide variety of moulded ceramic compositions.

Gives technical specifications that can be readily adapted to your individual materiel problems.

Write today! No obligation!

★ LAVOLAIN
★ THERMOLAIN
★ VITROLAIN
★ NU-BLAC
★ COMMERCIAL WHITE

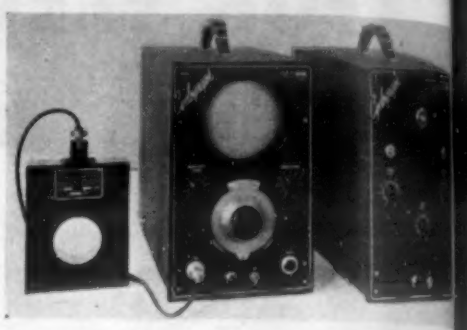
The STAR PORCELAIN COMPANY

MUIRHEAD AND JAY AVES. TRENTON, N. J

New Materials and Equipment

being produced by *J. W. Dice Co.*, 1 En St., Englewood, N. J.

Called the Cyclograph, the sorter



Both "single level" and "two level" sorti are available with the new Cyclograph.

pends upon magnetic principles for anal of the structure, hardness, case depth a brittleness of each part. It can be used reject only parts giving a low Cyclogra reading or to reject both above and bel an established acceptable range.

Testing speeds of from 1 to 5 parts p sec. are said to be attainable when parts a sent through the test coil on a belt conveyo

Heating, Heat Treatment

New Air Heater

Forced circulation of heated air for o erations up to 600 F is provided by a ne air heater produced by *W. S. Rockwell Co.* 200 Eliot St., Fairfield, Conn.

Known as the Gehnrich Atmospheric Ga Fired Air Heater, it not only permits ex isting units using other fuels to be readil converted to gas firing, but is said to im prove the efficiency of those ovens and dryers already heated by internal gas burn ers. Applicable wherever drying or baking is accomplished by hot air circulation and where there is no objection to contact of material with diluted products of gas com bustion the heater is useful for such opera tions as:

(1) baking of japan, lacquer and paint finishes and enamel
(2) drying coils, armatures, cores and molds
(3) curing of rubber
(4) baking plastics
(5) drying chemicals, paper, food, tex tiles and ceramic products

When a TAM* field engineer calls...

You can obtain a wealth of practical, useful and authoritative information by discussing your technical problems with a TAM sales engineer. He is well equipped to work for and with you. More than ten years ago he received his degree in Ceramic Engineering from one of our leading universities. Since then, his education has been broadened by wide experience. In the field, he has had his coat off and his hand-in on more than a few plant projects. His advance information on new developments and applications is a valuable asset.

Here is a man ready to work with you. You will find him intelligent and cooperative—quick to understand your problems. Furthermore, he is your direct contact with a fully equipped and staffed headquarters that is the source of much worthwhile information and data. When your TAM engineer calls, get the full value that his background offers you.

TAM
PRODUCTS
Registered U. S. Pat. Off.

*TAM is a registered trademark.

TITANIUM ALLOY MFG. DIVISION
NATIONAL LEAD COMPANY

Executive and Sales Office: 111 BROADWAY, NEW YORK CITY · General Offices, Works, and Research Laboratories: NIAGARA FALLS, N. Y.

DOW sets another new record of efficiency and cost reduction

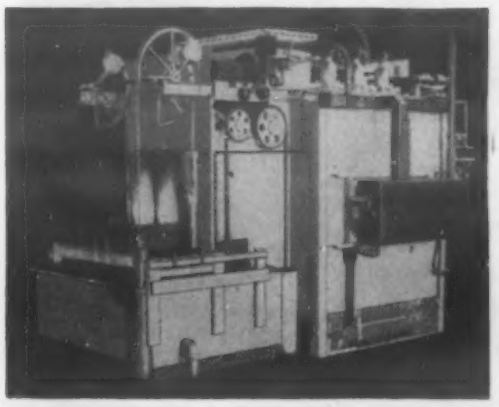
CASE HISTORY OF DOW HEAT TREATING PERFORMANCE ON SHIFTER SHAFTS AT TRACTOR PLANT

Heat Treatment: .005"-.008" effective case, carbonitrided 1500°F, Oil Quench, File Hard

Load: 640 Shifter Shafts, Fixture loaded, 1024 lbs. net—1384 lbs. gross

Heating Time: 70 minutes **Total Furnace Time:** 2 hours 10 minutes

Net Production: 472 lbs. per hour



By processing these parts in the Dow Furnace, distortion is reduced sufficiently to permit elimination of the grinding operation after heat treating. Since no case is removed by grinding, the specified depth of case is reduced, effecting still further savings in heat treating costs. Reductions in direct labor, material handling, machining and cleaning costs, coupled with improved quality, contribute to savings which can amortize the original cost of your Dow Furnace in a few months.

DOW FURNACE OFFERS

- Gas cyaniding for ⅓ to ¼ the cost of liquid cyaniding
- Uniformity of light case depths throughout load
- Unmatched versatility—gas cyaniding, gas carburizing, clean hardening or carbon restoration
- Improved quality. Forced, uniform quenching gives full hardness, reduced distortion.
- Maximum capacity with minimum investment and floor space

SEE US AT THE METAL SHOW BOOTH 2735

THE DOW FURNACE COMPANY

FIRST
WITH MECHANIZED BATCH-TYPE CONTROLLED ATMOSPHERE FURNACES

Maccabees Bldg. • Detroit 2, Michigan
TEmple 1-3553

New Materials and Equipment

(6) drawing and tempering

The heater is available in six capacities from 250,000 to 2,000,000 Btu.

Upright Electric Furnace

A new, upright electric furnace, featuring two different temperature ranges, has been developed by the *K. H. Huppert Co.*, 6830 Cottage Grove Ave., Chicago 37. Available both in a model which includes an inside

Full heat retention is assured in this upright electric furnace by multi-insulation, a heat-resistant transite board top and an asbestos seal recirculating door.

fan assembly for equalized temperatures up to 1250 F and one which has a maximum temperature of 2000 F, the vertical structure of the furnace makes it suitable for industrial applications such as basket heating, steel hardening or drying and firing of ceramics.

Lightweight Torch

No preheating, pumping or priming is required for the recently-introduced Prepo Torch which gives an instant heat at 2200 F.

Distributed by the *Air Reduction Sales Co.*, 60 East 42 St., New York 17, the lightweight (1½ lb.) torch is said to be useful for such operations as soldering joints, loosening nuts and sweating cable. Features claimed for the torch are:

1. a throw-away fuel container

How to make Stoody Hard-Facing **WORK** harder for you

To help you select the *best*, longest lasting, most economical wear protection on a cost/hour basis, we've prepared this new booklet, "Stoody Alloys." Not only does it furnish a concise description of and pertinent information on each Stoody Hard-Facing Alloy, but it lists hundreds of pieces of wearing equipment with the recommended alloy for maximum protection. By following the Stoody Alloys recommendation, you'll save many hours of trial and error, because all selections have been made only after many years of testing.

SEE YOUR DEALER or write for your copy today! Simply ask for the new issue of "Stoody Hard-Facing Alloys." For more complete data on any individual Stoody Alloy, detailed circulars are available.

STOODY COMPANY
11959 EAST SLAUSON AVENUE
WHITTIER, CALIFORNIA

You need your own personal copy of "Stoody Hard-Facing Alloys" if you now operate any equipment in these industries!

Construction
Lumber and Paper
Rock Products
Cement
Brick and Clay
Metal Mining
Coal Mining
Iron and Steel
Coke and Gas
Foundries
Power Plants
Petroleum
Railroads
Agriculture
Automotive

SHARONSTEEL

It's almost magic the way Brainard tubing consistently fabricates just the way you want it to — the way the scrap ratio stays at a minimum — the constant uniformity through and through.

But actually there's no magic to it — Brainard welded mechanical tubing does the trick because it is quality controlled from ore to strip to tube. This means by using Brainard you can build more value into your product.

Next time you want ductile, easier-working tubing, get in touch with one of the Brainard offices listed below. The results will impress you.

QUALITY CONTROLLED FROM ORE TO PRODUCT BY BRAINARD

Straight or Fabricated

SIZES: ½" to 4" — .025 to .165

TUBING DIVISION

BRAINARD STEEL COMPANY

2339 LARCHMONT AVENUE WARREN, OHIO

There are Brainard sales offices in Atlanta, New York, Cincinnati, Pittsburgh, Buffalo, Chicago, Philadelphia, Detroit, Cleveland, Indianapolis and Nashua, N. H. Sales Representatives: Sharonsteel Products Co. in Detroit, Grand Rapids, Mich.; and Farrell, Pa. Fred J. Reynolds, Davenport, Ia; Brass & Copper Sales Co., St. Louis, Mo.

New Materials and Equipment

2. a constant flame until fuel is exhausted
3. clean odorless heat
4. tool-box size—approximately 6½ in. high, without the burner, and 4 in. in dia.

Under ordinary service one fuel container will last more than 4 hr.

Portable Induction Heating Unit

A low-cost, portable, high frequency induction heating unit which will operate continuously regardless of load condition has been developed by *Lepel High Frequency Laboratories, Inc.*, 41 West 60 St., New York. Measuring only 20 by 26 by

Carbide tips can be brazed to cutting tools with this portable induction heating unit.

16 in., the unit is said to be suitable for hardening, annealing, normalizing and soldering ferrous and nonferrous metals.

Performance data released on the unit indicate that it will:

(1) Heat a 1-in. length of steel rod to 1500 F in approximately 3 sec.
(2) Braze carbide tips to cutting tools up to 1½ in. square.
(3) Melt 4 oz. of steel or brass in 4 min.

For uniformity and speed in production, heating cycles can be preset for desired temperatures with an automatic timer.

Heating Safety Device

Development of a constant stand-by safety control for use with existing controller circuits on automatic or manually operated furnaces has been revealed by *Illinois Testing Laboratories, Inc.*, 420 N. LaSalle St., Chicago 10.

Called the Pyrotac, the control unit is used for shutting down heater circuits on

Talide Work Rolls

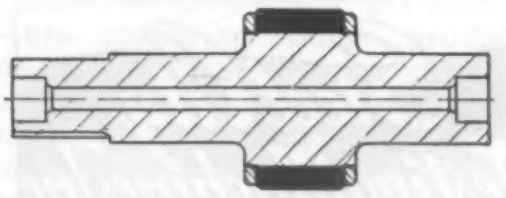
Solid Carbide Rolls
(weighing up to 1000 pounds)
for Strip or Sheet

● Profitable, increased tonnage with Talide Carbide Rolls can be had Mills regularly report astounding new figures. What's more, increased operating speeds and improved surface finish make subsequent polishing and buffing unnecessary.

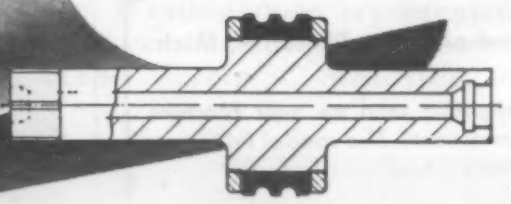
Talide Tungsten Carbide Rolls are used for ordinary finish or mirror-finish on such items as cold rolled stainless, spring steel, razor steel, alloys, carbon, aluminum foil, tinsel ribbon and flat wire.

Metal Carbides Corporation originally developed the art of making Carbide Rolls, and only this firm makes solid or sleeved Talide Carbide Rolls weighing up to 1000 pounds. Available in diameters up to 10" and lengths up to 40". We make the smallest and largest rolls in the world!

Write us today. We'll show you how to get *more production, better finish, higher speeds, less down time, closer tolerances, greater reductions* and *fewer rejects* on your mill operations.



Sleeved Rolls for Flat Wire



For Shape Wire

SINTERED CARBIDES
METAL CARBIDES CORPORATION
TALIDE MC
YOUNGSTOWN, OHIO.
HOT PRESSED CARBIDES

METAL CARBIDES CORPORATION

YOUNGSTOWN 5, OHIO *Pioneers in Tungsten Carbide Metallurgy*

CUTTING TOOLS · DRAWING DIES · WEAR RESISTANT PARTS

Send for this
BROCHURE

YOU WILL FIND IT VALUABLE FOR READY REFERENCE

This brochure, file catalogue size 8½ x 11", contains needful facts and information on Brinell hardness, ductility, compression, tensile, transverse and hydrostatic testing machines and proving rings. Also information on special testing equipment. You may at some time want to have quick information on physical testing equipment and this catalogue in your files makes such information available to you immediately.

Steel City Testing Machines Inc.

8833 Livernois • Detroit 4, Mich.

Without obligation send me your brochure on testing instruments. Also special folders on following types (check your interest):

☐ Brinell Hardness ☐ Ductility
☐ Compression ☐ Tensile
☐ Transverse ☐ Hydrostatic
☐ Proving Rings

NAME_____

TITLE_____

Attach coupon to your letterhead and mail

New Materials and Equipment

any electric or fuel-fired unit and can also be connected to sound an alarm, making it ideal for use on heat-treating furnaces and kilns. If the thermocouple or extension wire should break or burn out, it is claimed that the Pyrotac will shut down the heating equipment automatically.

The Pyrotac is available in scale ranges from 0 to 600 F and 0 to 3000 F and their centigrade equivalents.

•

General

Electropolisher for Metal Samples

A device that is said to polish and etch metal samples used for microscopic examination in less than a minute is being manufactured by the *Central Scientific Co.*, 1700 Irving Park Rd., Chicago 13.

Called the Cenco-Hangosky Electropolisher, it can be used to prepare proper microscopic samples of ferrous and nonferrous metals and many types of alloys. Automatic controls regulates the time and the amount of current necessary for specific jobs, while interlocks and switches are designed to insure safe operation at all times.

Demagnetizing Coil

An improved design of demagnetizing coil which is said to be highly effective in demagnetizing materials and stabilizing magnetic flux has been announced by the *Special Products Div.* of the *General Electric*

This new GE demagnetizer can accommodate a variety of sizes and shapes.

ENGELHARD
meets every
THERMOCOUPLE
NEED!

Noble Metal Thermoelements and Thimbles

platinum vs. platinum-rhodium—repaired at substantial savings with credit for reclaimed metal.

Base Metal Thermoelements

chromel vs. alumel iron vs. constantan copper vs. constantan

Standard Insulators

All types and sizes

Primary and Secondary Protection Tubes

Terminal Heads and Lead Wire, etc.

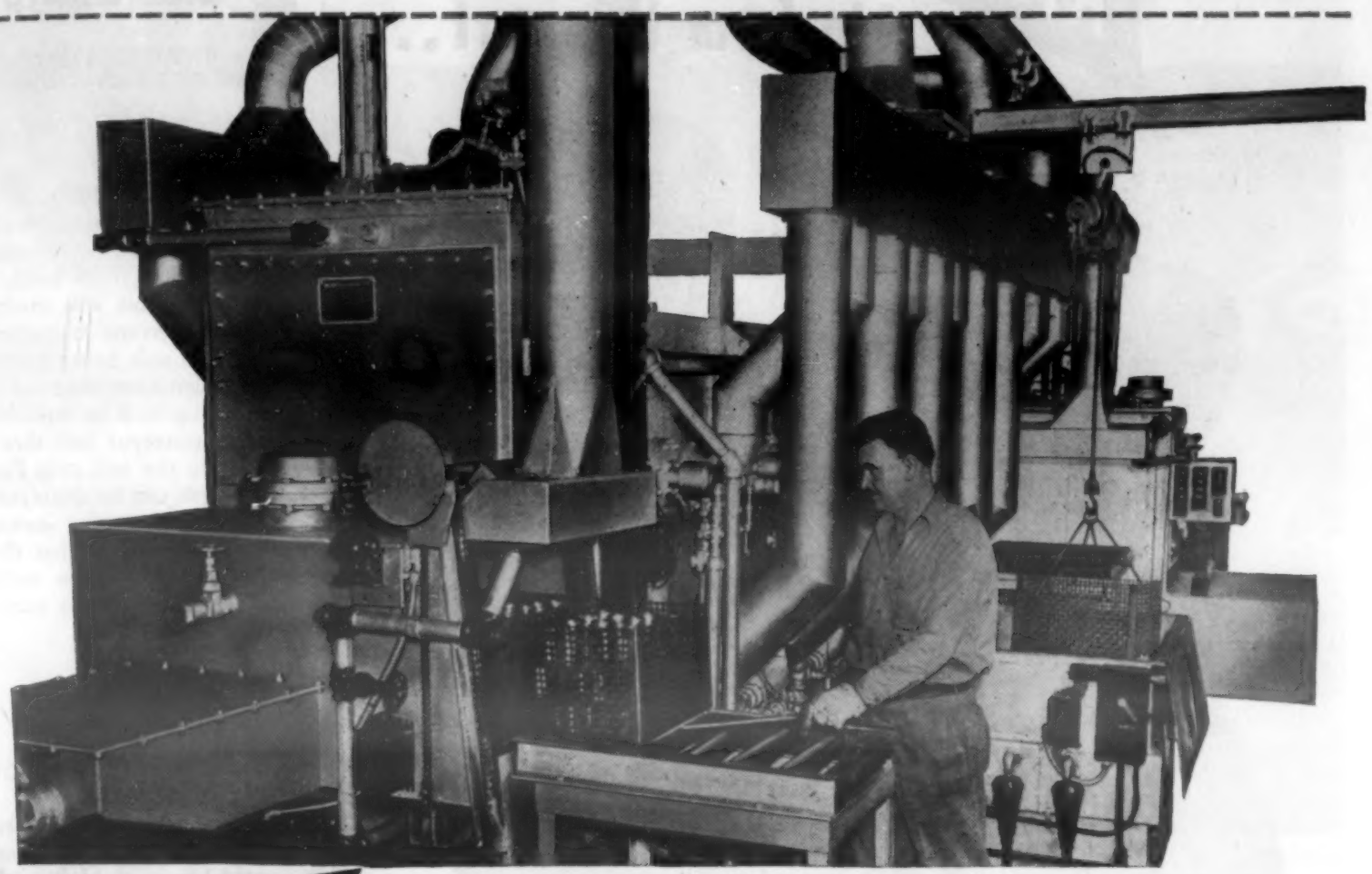
At Engelhard, you will find a complete line of thermocouples and accessories to meet all requirements. The individual parts of Engelhard thermocouples are selected and assembled for your specific conditions of atmosphere and temperature. You can rely on Engelhard's more than 40 years of research and instrument-building experience to solve your temperature measurement problems. Write for complete information today.

CHARLES ENGELHARD, INC.

850 PASSAIC AVE., EAST NEWARK, N. J.

YOU CAN BE **SURE**.. IF IT'S

Westinghouse



FOR THE MAN WHO CAN'T BE SOLD

Here's the solution to your Gas Carburizing Problems

Westinghouse Therm-a-neering has the answers. This engineering and metallurgical service is offered with no obligation to the man who "can't be sold", but, who is willing to accept *proof* of efficiency and dependability. Therm-a-neering custom-builds equipment to fit your individual requirements, assuring smooth and economical operation of your heat-treating line.

Take the carburizing furnace shown above, for example: one continuous and complete operation puts all parts through the same cycle, same atmosphere, same temperature. Uniformity of parts is assured. Rejects are eliminated.

And the work is done fast. No handling of parts is required between charging and discharging. Doors open automatically. One operator handles all work easily. Production is maintained at 800 net pounds per hour.

This installation is typical of the way Westinghouse furnaces—both gas-fired and electric—are answering today's production problems. And because Westinghouse engineers have no favorite to play, they can study your problems from an unbiased point of view in helping you select the equipment to do your job most efficiently and economically.

Let Therm-a-neering help you. Call your nearby Westinghouse representative for details, or write Westinghouse Electric Corporation, 180 Mercer St., Meadville, Pa. J-10350

Therm-a-neering. A HEAT AND METALLURGICAL SERVICE THAT OFFERS WITHOUT OBLIGATION:

ENGINEERS—Thermal, design and metallurgical engineers to help you study your heat-treating problems with a view toward recommending specific heat-treating furnaces and atmospheres.

RESEARCH—A well-equipped metallurgical laboratory in which to run test samples to demonstrate the finish, hardness and metallurgical results that can be expected on a production basis.

PRODUCTION—A modern plant devoted entirely to industrial heating.

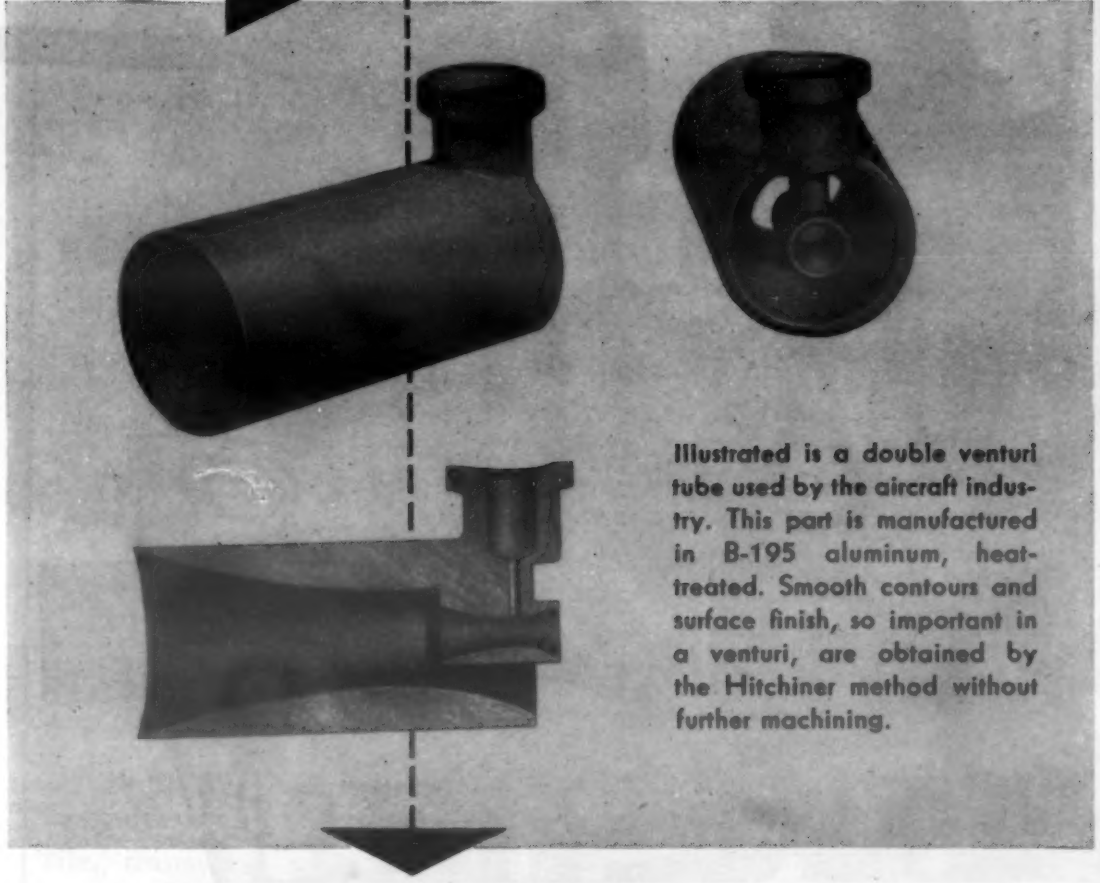
EXPERIENCE—Manufacturers of a wide variety of furnaces—both gas and electric—and protective atmosphere generators.

Westinghouse

GAS AND ELECTRIC

Furnaces

There is one **RIGHT WAY** to form this part...



Illustrated is a double venturi tube used by the aircraft industry. This part is manufactured in B-195 aluminum, heat-treated. Smooth contours and surface finish, so important in a venturi, are obtained by the Hitchiner method without further machining.

A PRECISION INVESTMENT CASTING by HITCHINER

Hitchiner engineers and metallurgists are solving small parts production problems in almost every industry. If you have parts which require costly and intricate machining, it will pay you to investigate the Hitchiner method of precision investment casting.

- **Small Quantities:** The low tooling cost for Hitchiner castings often makes small quantities more practical by this method where normally they would be manufactured by other processes only in large volume.
- **Mass Production:** The Hitchiner method is particularly well adapted to quantity production of intricate parts normally involving high machining or assembly costs. Projections, recesses, irregular holes, external under-cuts and similar operations which ordinarily present difficult manufacturing problems, can be usually incorporated into a Hitchiner casting.
- **Tolerances:** Plus or minus .005 per linear inch or diameter, with plus or minus .0015 the closest and plus or minus .010 the greatest required, are the normal working tolerances. On many dimensions closer tolerances can be held, especially in non-ferrous metals.

Send us your blue prints and permit our metallurgical and engineering staff to offer competent advice on your small metal parts problems.

HITCHINER MANUFACTURING CO., INC.

Manchester, N. H.

Sales Office: 967 Farmington Ave., West Hartford 7, Conn.

AGENTS IN ALL PRINCIPAL CITIES

New Materials and Equipment

Co., Schenectady, N. Y. Suitable for use on any unshielded, magnetically-soft material, the coil is said to eliminate undesirable magnetic flux from tools, drills, punches, small arms and any machined parts that may have become magnetized.

The coil axis being horizontal, mass production demagnetizing can be accomplished on stock up to 8 in. wide by passing a non-metallic conveyor belt thru the instrument parallel to the coil axis. Pieces of considerable length can be demagnetized, or several small pieces can be demagnetized simultaneously, provided that they are not in a metal container or in sufficient contact to cause shielding of any part.

Bearing Grease

A general purpose bearing grease with the ability to withstand both high and extremely low temperatures is being produced by *Master Lubricant Co.,* Meadow & Jackson St., Philadelphia. This product, called Lubriko M-6, is said to have a melting point (by ASTM methods) of more than 370 F while it remains operative at temperatures lower than −40 F.

Lubriko M-6 is recommended for use in electric motor lubrication, for high and low speed shaft bearings, conveyors, drying kilns, machine tools, high-speed printing presses, and most other anti-friction bearing devices. It is especially suited for installations in climates where seasonal changes are extreme.

Plastic Cutting Block

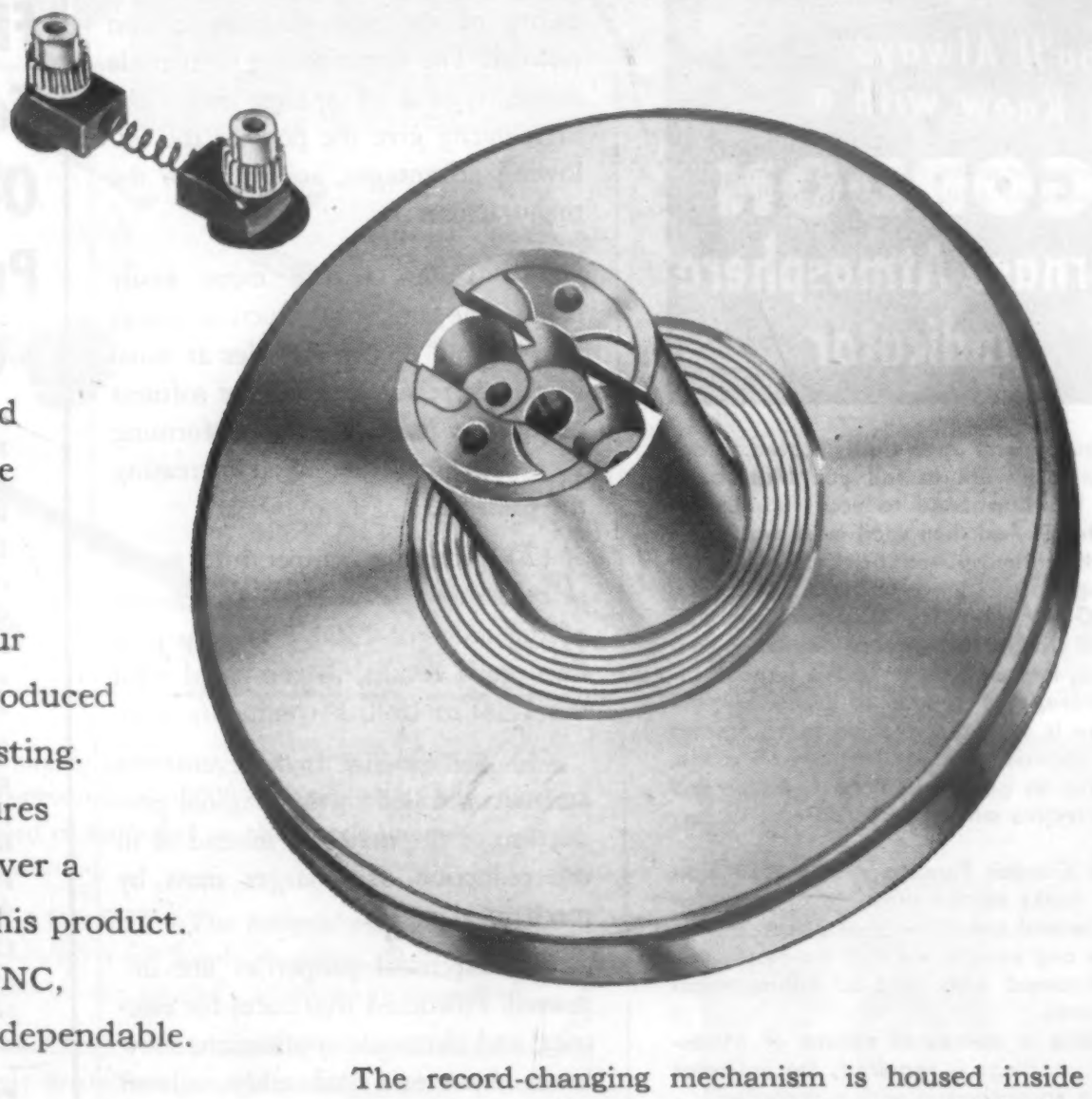
Colonial Rubber Co., Ravenna, Ohio, has announced the manufacture of a new cutting block made of Tygon plastic.

Colonial cutting blocks are self-healing, can be used on both sides, and are said to have an unusually long life. Production costs can be reduced on clicking and mallet cutting operations by preventing rejects from double cutting due to "bounce backs," lessening intervals between die resharpening, and virtually eliminating die breakage.

Materials such as rubber, leather, plastics, cork, fiber, felt, cloth, paper, foils, or light gage metals can be die cut clean on the Tygon surface. There is no danger of getting foreign material in stock, according to the manufacturer, and stock of different colors can be cut without fear of cross contamination.

Zinc-base die castings

have major role in RCA Victor's famous 45-rpm record changer



In RCA Victor's revolutionary 45-rpm record changer, Model 9-EY-3, the turntable, pinions, spindle, main cam, cycle lug and star wheel are die cast. Four of these components are produced as a single zinc-base die casting. Zinc of proper quality assures the dimensional stability over a prolonged period vital to this product. ANACONDA ELECTRIC* ZINC, 99.99+% pure, is *always* dependable. Anaconda Sales Company, 25 Broadway, New York 4, New York, Subsidiary of Anaconda Copper Mining Company.

B0294

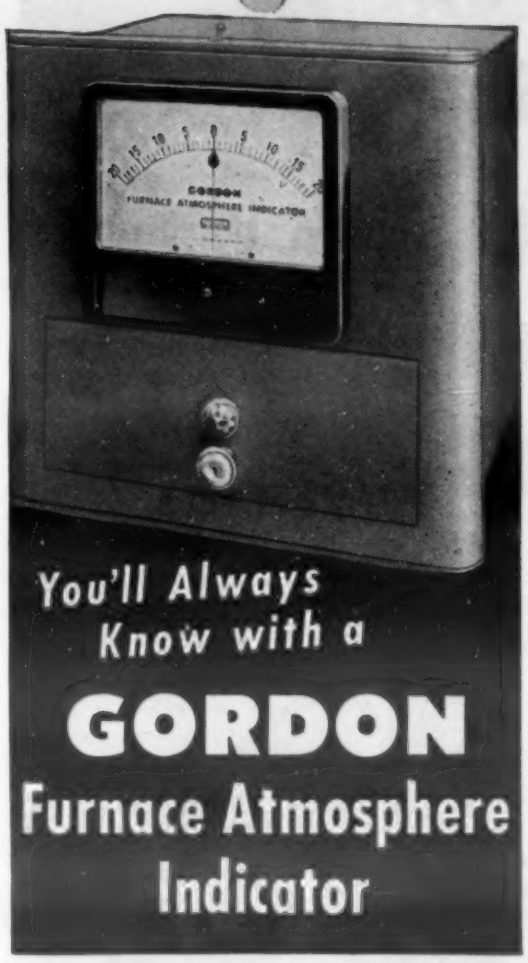
*Reg. U.S. Pat. Off.

The record-changing mechanism is housed inside the enlarged central post of the zinc base turntable die casting shown here. Zinc-base die cast pinions fit down inside the top of the central post. Photograph and data by courtesy of the Radio Corporation of America and the Doehler-Jarvis Corporation.

Look to ANACONDA for:

Copper • Zinc • Lead • Silver • Cadmium • Bismuth • Arsenic

Correct Furnace Atmosphere



You'll Always Know with a

GORDON

Furnace Atmosphere Indicator

Do you depend upon badly scaled or decarburized work to tell you that something has happened to your furnace atmosphere? And then spoil more work getting the atmosphere back to where it belongs?

A Gordon Furnace Atmosphere Indicator will watch that for you. It makes a continuous, thorough check of the furnace atmosphere, and as soon as it changes, the change is detected and indicated so that quick necessary adjustment can be made. It works on gas or oil-fired furnaces and in protective atmospheres on electric furnaces.

The Gordon Furnace Atmosphere Indicator works on the principle of the relative thermal conductivity of gases. It is so simple and easy to use that top results can be obtained with shop or non-technical personnel.

Where a continuous record of atmosphere readings is required, the indicator can be co-ordinated with a recorder.

You can't afford to be without this instrument any longer.

Price, complete with U-tube and Sample Filter, 110 V, 60 C, **$335.00**

Write for descriptive bulletin for full information.

GORDON SERVICE

CLAUD S. GORDON CO.

Specialists for 36 years in the Heat-Treating and Temperature Control Field

Dept. 24, 3000 South Wallace St., Chicago 16, Ill.
Dept. 24, 2035 Hamilton Ave., Cleveland 14, Ohio

A New Electrolytic Iron Powder

● A NEW TYPE of iron powder for the powder metallurgy field has been announced by Powdered Iron Corp., Detroit, and is now being produced on a pilot plant scale for industry. The powdered iron resembles Swedish sponge iron physically, but has the purity of the best electrolytic iron powder. The combination of particle shape, typical of sponge iron, and high purity give the powder the following advantages, according to the manufacturer:

(1) Compacts are more easily made. The dendritic structure causes interlocking of the particles at usual working pressures, while the softness of the iron itself permits the forming of a dense compact upon increasing the pressure.

(2) Sintering temperature seems to be somewhat lower. Temperatures of the order of 1300 F and up produce good results, as compared with the 1500 to 1800 F commonly used.

(3) Particle size is more uniform and is controlled in the original production of the material, instead of in the reduction of a larger mass by mechanical means.

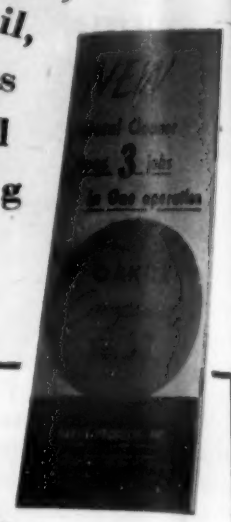
(4) Electrical properties are improved. Powdered iron cores for electrical and electronic applications show lower hysteresis and eddy current losses, due to the lower density of the compact when produced for core purposes.

How Powder Is Produced

For the new process, ordinary cast iron or mild steel scrap in the form of borings or turnings are the raw material. These are placed in a chemical bath in iron trays, and become the

(Continued on page 138)

All at one time . . . **it removes rust, removes oil, prepares the metal for painting**



This FREE Folder Tells About Oakite's Great New Pre-Paint Cleaner

OAKITE Compound No. 33 is a cleaning-phosphating material that simultaneously removes oil and rust and conditions the metal surface for painting.

It also removes heat scale and other oxides, carbon smut, soldering and welding residues, identification inks and other soils from steel, cast iron, aluminum sheet and castings.

Oakite Compound No. 33 is a great soak cleaner for metal parts of moderate size; and great for hand-swabbing on large pieces like cabinets, desks, doors and truck cabs.

Oakite Compound No. 33 saves money; *frequently eliminates pickling operations on moderately rusty steel.*

FREE Write to Oakite Products, Inc., 32H Thames St., New York 6, N. Y., for your copy of Folder F7993 on *"Oakite Compound No. 33".*

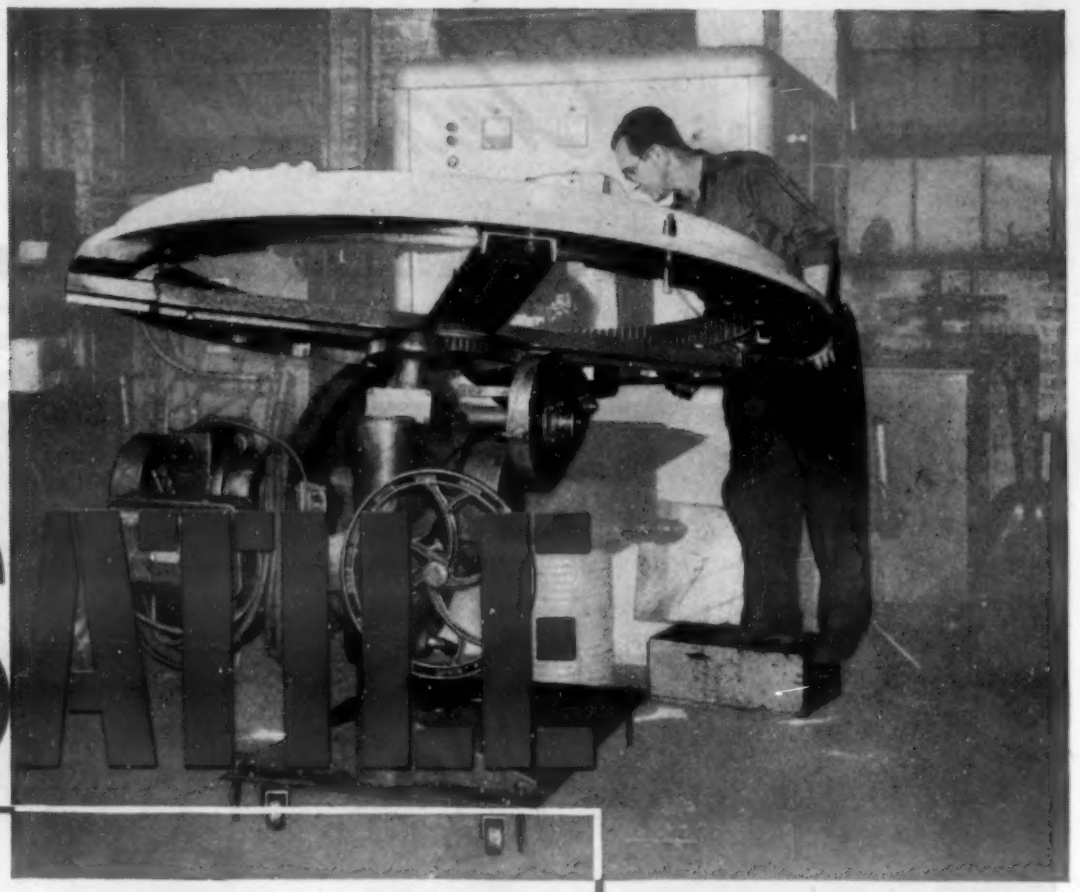
SPECIALIZED INDUSTRIAL CLEANING

OAKITE

MATERIALS • METHODS • SERVICE

Technical Service Representatives Located in Principal Cities of United States and Canada

VERSATILE



"Internal ring gear being hardened on the Lindberg LI-25 Induction Heating Unit".

Investigate the amazing versatility of the Lindberg Induction Heating Unit—approximately 2000 different parts have been selectively hardened or annealed on this typical commercial heat treating installation.

FROM THE LARGEST—The internal ring gear illustrated above—with a 60" inside diameter, 3½" face with 187 teeth each individually heated and oil spray quenched.

TO THE SMALLEST—This small 2" stamped metal rocker arm was selectively heated and water quenched on the small square face at the rate of 3000 per hour. Investigate this versatile Lindberg Induction Heating Unit—it may supply the answer to your selective heating operations.

SPECIFY LINDBERG

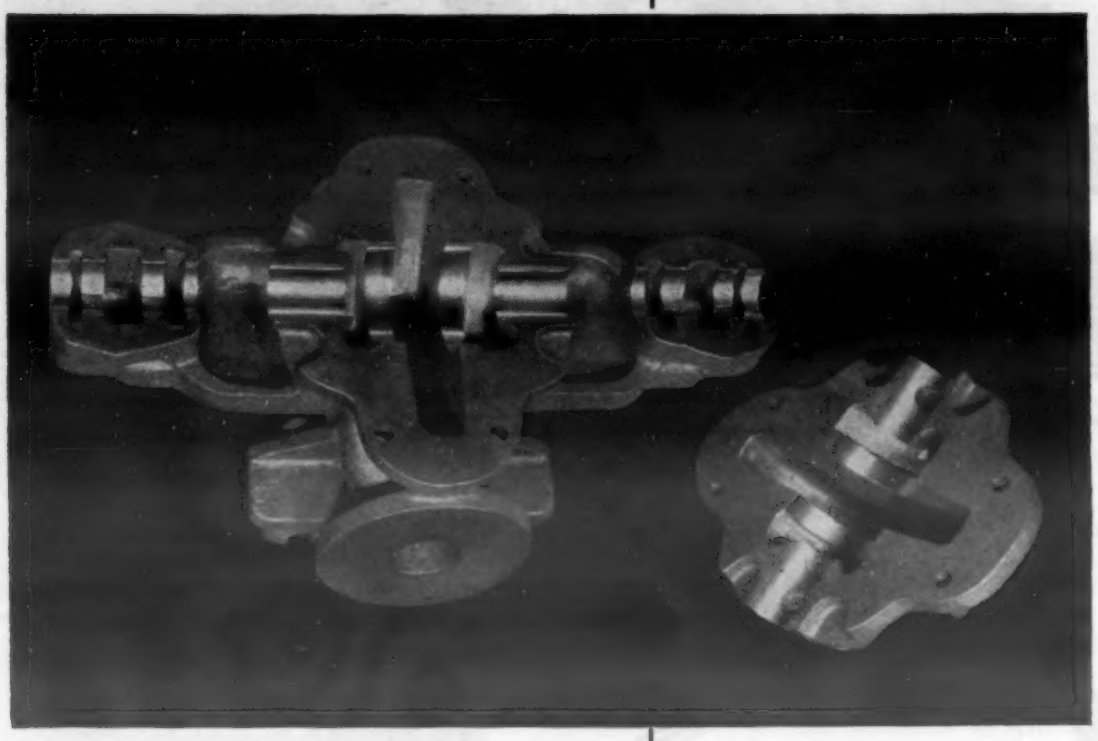
for any heat treating or melting need! Lindberg manufactures every type and many sizes of melting and heat treating furnaces from tiny laboratory units to mammoth field erected installations—whether it's gas, oil, electric, arc, low or high frequency—consult your local Lindberg Office!

LINDBERG
HIGH FREQUENCY DIVISION

LINDBERG ENGINEERING COMPANY, 2451 W. Hubbard St., Chicago 12, Illinois

CORROSION... *Checkmated!*

WITH LEBANON STAINLESS CASTINGS



METALLURGISTS AND PRODUCTION MEN are pointing the way to corrosion control by the use of stainless alloys. These alloys range from the general purpose (19-9) to the highly specialized types, each particularly suited to service requirements. Lebanon Circle Ⓛ 22 (analysis at right) is a typical example of a stainless alloy that adds years of usefulness to any casting that must withstand corrosive attack.

Lebanon laboratory and production techniques play an important part in maintaining the high quality of our castings. Modern electric induction furnaces provide maximum flexibility of control so valuable in processing alloy material.

Our engineers are at your service, anxious always to help you solve your problems by developing entirely satisfactory castings.

If you do not have copies of our Data Sheets we will be glad to send them on to you.

LEBANON STEEL FOUNDRY • LEBANON, PA.
"In the Lebanon Valley"

Finish-machined casting of a Centrifugal Pump Casing made at Lebanon of Circle L 22 Stainless Steel.

LEBANON CIRCLE Ⓛ 22

NOMINAL ANALYSIS

Carbon Max.	0.08
Silicon	1.25
Manganese	0.75
Chromium	19.50
Nickel	9.00

NOMINAL PHYSICAL PROPERTIES

Tensile Strength	75,000
Yield Point	36,000
Elongation in 2"—%	50
Brinell Hardness	135

HEAT TREATMENT:
Water Quenched

LEBANON *ALLOY AND STEEL* Castings

CIRCLE L

Electrolytic Iron Powder

continued from page 13

anode in the electrolytic reaction th occurs. Iron is dissolved out chem cally, and is deposited from the solu tion in a mercury cathode that be comes impregnated with the iron. The iron is recovered in fine particle form by distillation of the cathode soft pulverizing, and air classification There is no severe mechanical reduc tion of a large mass, so that the den dritic structure of the powder as obtained from the cathode is not destroyed.

The particle shape of the materia can be translated into greater green strength in compacts, due to the in terlocking of the particles; or in greater compressibility of the powder due to the readiness with which th dendritic structure can be compacted A result is that usable compacts ca be made with low apparent density The powder, as supplied commercial ly, has an apparent density of 2.4 to 2.5 gm. per cc, but it can be supplie in apparent densities as low as 1. or as high as 2.8 gm. per cc.

High Purity Obtained

High purity is obtained by th process because there is no residua unreduced oxide, as in the sponge processes. Purity of the final powder is about 99.8% iron. Absence o silica means avoiding the abrasiv effect of this substance during com pacting.

The new iron powder is price competitively with standard iron pow ders now on the market.

Patents have been applied for t cover the new features of the manu facturing process. While a limited commercial production is now avail able from the pilot plant, additional facilities will shortly be complete to increase the capacity considerably

The new material is expected t go into all the fields of applicatio for which present iron powders ar suitable. It should have special advan tages where a high-purity material needed for low-density compacts, a in electronic work, the producers su

A Typical Machine Shop Reports:

33% BETTER PRODUCTION

...Longer Tool Life

...Better Finish

WITH J&L FREE-CUTTING "E" STEEL

...THE NEW FREE-CUTTING BESSEMER SCREW STOCK

Hundreds of profit conscious machine shops throughout the metal-working industry have switched to J&L "E" Steel to ensure dollar savings through longer tool life and increased production.

Here's a report from a typical independent shop which produced the parts shown actual size at right:

"J&L 'E' Steel machines very well . . . the finish obtained has been excellent . . . our tool life has been increased . . . we have been able to realize 33% better production. We are interested in changing all our specifications to your new 'E' Steel."

These are reasons why J&L "E" Steel has been so enthusiastically accepted throughout the industry. But there are others—four years of exhaustive field testing in over 100 applications proved J&L "E" Steel's superiority. Now since "E" Steel has been on the market, 80% of the new users report:

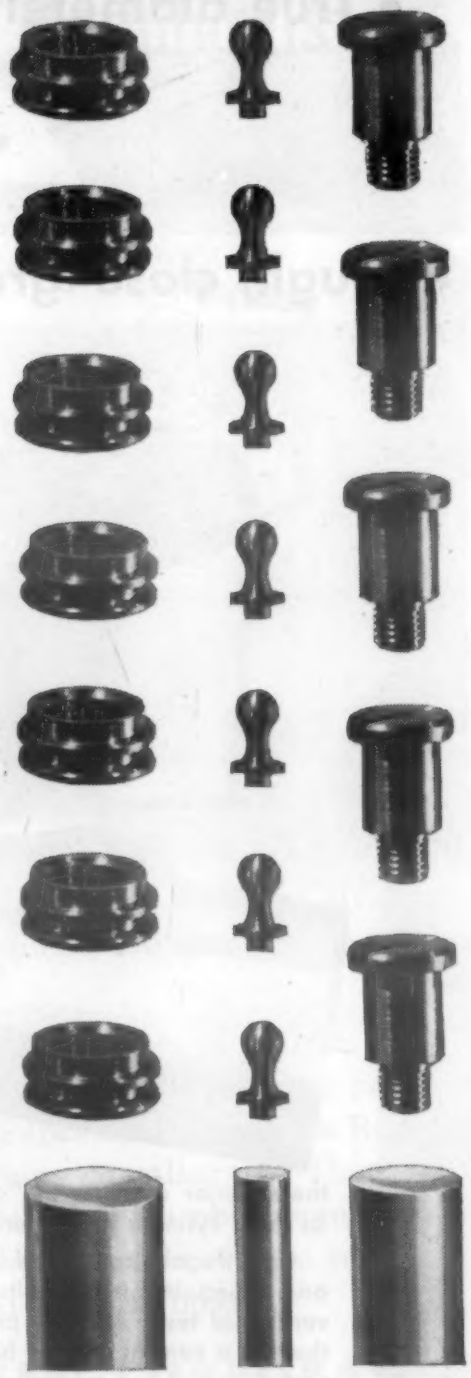
- ★ Better Machine Finish
- ★ Longer Tool Life
- ★ Higher Speeds
- ★ Machinability Ratings up to 170
- ★ Better Response to Forming and Cold Work

J&L "E" Steel is made in three grades: *E-15*, *E-23*, and *E-33*, each within the composition limits of the standard bessemer screw steels and with similar tensile properties.

Investigate the production economies you can gain with J&L "E" Steel. Write today for your free copy of the booklet "Faster Machining... Smoother Finish . . . Longer Tool Life." It will give you additional information on properties, grades and their equivalents, and applications.

"E" Steel (U.S. Pat. No. 2,484,231) is easily identified by the distinctive blue color on the end of every bar.

J&L STEEL



PARTS SHOWN ACTUAL SIZE

JONES & LAUGHLIN STEEL CORP.
474 Jones & Laughlin Building
Pittsburgh 30, Pennsylvania

Please send me your booklet, "Faster Machining . . . Smoother Finish . . . Longer Tool Life," describing J&L "E" Steel.

NAME_____

ADDRESS_____

COMPANY_____

_____

JONES & LAUGHLIN STEEL CORPORATION

From its own raw materials, J&L manufactures a full line of carbon steel products, as well as certain products in OTISCOLOY *and* JALLOY (*hi-tensile steels*).

PRINCIPAL PRODUCTS: HOT ROLLED AND COLD FINISHED BARS AND SHAPES • STRUCTURAL SHAPES • HOT AND COLD ROLLED STRIP AND SHEETS • TUBULAR, WIRE AND TIN MILL PRODUCTS • "PRECISIONBILT" WIRE ROPE • COAL CHEMICALS

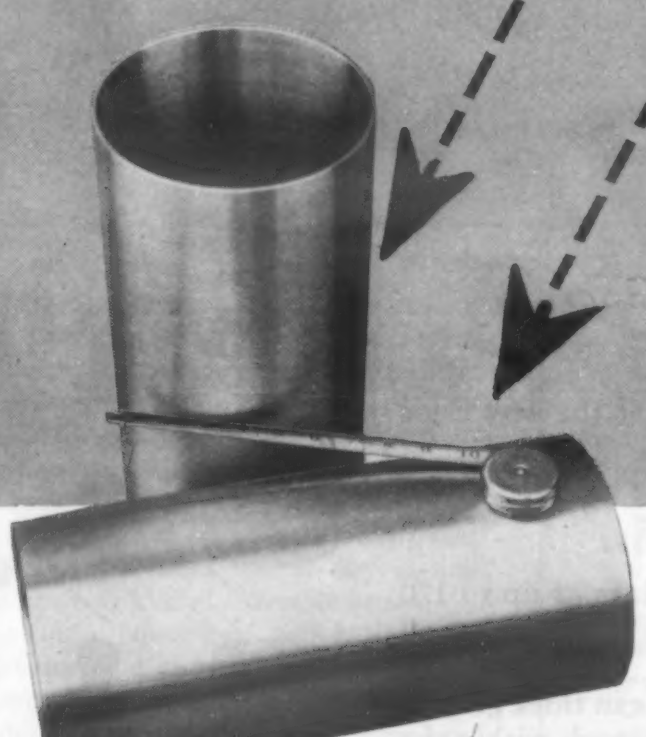
DURASPUN

18-8 Cylinder Liners

• True diameters

• True wall thicknesses

• Tough, close-grain metal



Are you thoroughly familiar with the superior qualities of "centrifugally cast" high alloys . . . such as these cylinder liners, for example?

Centrifugally cast metal is exceptionally uniform, close-grained and strong. It is free of pits and pockets. It is capable of passing very rigid tests. And the practical advantage is that as long as there is a central circular hole, almost any outside shape can be cast. Some of our customers want their castings centrifugal even though considerable boring and other machining is necessary to finish the piece.

We recommend our centrifugal casting service if your requirements call for the characteristics outlined above. Our high alloy foundry is modern in every respect and staffed by metallurgists and foundrymen of many years' experience with both centrifugal and static castings.

THE DURALOY COMPANY

Office and Plant: Scottdale, Pa. • *Eastern Office*: 12 East 41st Street, New York 17, N. Y.

F. O. NELSON, 1743 McCormick Building, Chicago, Illinois

Detroit: F. B. CORNELL & ASSOCIATES

METAL GOODS CORP., St. Louis • Houston • Dallas • Tulsa • New Orleans • Kansas City

News Digest

Continued from page 9

ing its cold workability, and the alloys are not brittle in the annealed state. Because of these properties the alloys might be useful for filament and filament supports where rigidity and resistance to mechanical shock are required.

Lead Additions in Steel Evaluated

A recent report published in the British *Journal of the Iron and Steel Institute* (July, 1950) confirms marked improvement in machinability obtained by lead additions to a large number of carbon and alloy steels.

At the same time the authors, J. Woolman and A. Jacques, found that 0.15 to 0.20% additions of lead have generally minor effects on normal tensile and impact properties of the steel in either the longitudinal or transverse directions. In some cases a slight tendency to lower ductility and toughness with addition of lead was observed.

However, marked reductions in fatigue resistance may result from lead additions; these reductions become greater as tensile strength of the steel increases. Thus, for a 78,000 psi. steel, the reduction was negligible; for a 107,000 psi. steel, it was about 5 to 10%; and for a 164,000 psi. steel, about 20%. Notch sensitivity in fatigue was not affected by lead additions.

Aluminum Nomenclature Clarified

Standard nomenclature for aluminum sheet and plate has been adopted by The Aluminum Assn. in order to clarify designations of these products. The new definitions are:

Plate—a solid section rolled to a thickness of 0.250 in. and heavier, in rectangular form with either sheared or sawed edges.

Sheet—a solid section rolled to a

Mr. Parks had a tubing problem . . .

so he called in the ELECTRUNITE Metallurgist . . .

and in practically no time at all . . .

Mr. Parks manufactures school desks. Very good desks, too . . . but, even so, Mr. Parks is always looking for ways to make them better.

This is the way Mr. Parks' problem came about . . . 1½" x 11 gauge tubing is bent U shape to form a support for both seat and table of Mr. Parks' desks. Design calls for a short radius bend, and he was using a fully normalized tube that Rockwell "B" tested under 55.

"Not stiff enough", decided Mr. Parks. "No desk of mine is going to sag when a heavyweight leans against it! On the other hand, the tube must not be so hard it breaks in bending." What to do? — one thing, of course, and Mr. Parks did it. He called in the ELECTRUNITE Tubing Metallurgist. As a result of this call, processing changes were made resulting in a stiffer tube with a higher yield point and a higher Rockwell reading. These tubes readily take the short radius bend and still give Mr. Parks' desks the extra sturdiness and strength he wanted them to have.

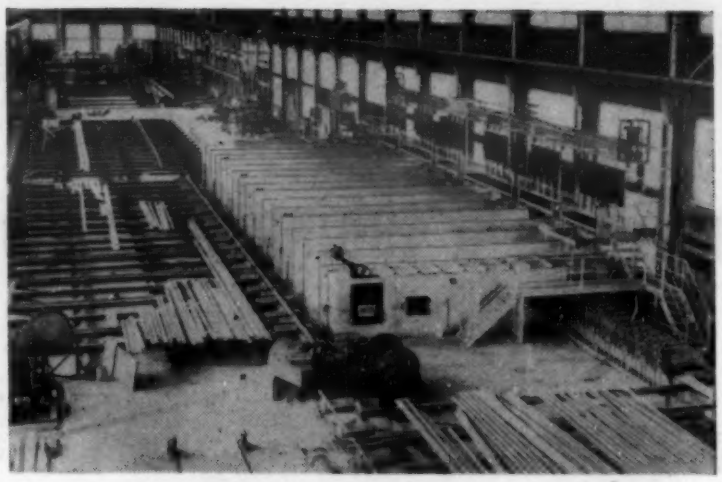
Mr. Parks isn't his real name, of course, but his problem was real. When you have a tubing problem, why not do as Mr. Parks did? Call for a Republic ELECTRUNITE Tubing Metallurgist. There is no charge for his services and no obligation on your part for his help. Just let us know when you would like to see him—and he'll be there.

REPUBLIC STEEL CORPORATION
STEEL AND TUBES DIVISION • CLEVELAND 8, OHIO
Export Department: Chrysler Building, New York 17, New York

Republic
REPUBLIC STEEL ®
ELECTRUNITE® TUBING

for
HOMOGENIZING
SOLUTION TREATING
AGING
BILLET HEATING
BRAZING
FINISH ANNEALING
OR ANY OTHER PROCESS

There's an **EF** furnace to handle any product or production



Completely Automatic EF Furnace Heats and Quenches Aluminum Shapes up to 90 Feet Long.

● Our wide experience in the processing of aluminum, magnesium and other non-ferrous and ferrous products can save you time and money. We build continuous and batch type furnaces,— gas fired, oil fired or electric . . . whichever is best for your particular requirement — furnished complete with all necessary charging, discharging, quenching, special atmosphere and special handling facilities. For long, efficient, trouble-free service, let EF engineers work with you on your next furnace problem.

Gas-Fired, Oil-Fired EF and Electric Furnaces
for any Process, Product or Production
THE ELECTRIC FURNACE CO.
WILSON ST. at PENNA. R. R. Salem - Ohio

AJAX
HIGH TENSILE MANGANESE BRONZE

- *high in strength, toughness and corrosion resistance . . . . . .*
- *long time favorite with manufacturers of marine fittings . . . . . .*
- *leaves sand clean and bright—takes a mirror-like finish . . . . . .*
- *recognized as the highest quality manganese bronze available . . . . . .*

AJAX METAL DIVISION
of H. Kramer & Company
PHILADELPHIA, 23, PA.

News Digest

thickness range of 0.006 to 0.249 in. inclusive, supplied with sheared, slit or sawed edges. *Flat sheet* is furnished in rectangular form with sheared, slit or sawed edges which can be flattened by any standard method. *Coiled sheet* is furnished in rolls with slit edges.

Soldering Booklet Available

A detailed description of solders and soldering procedures has been issued as a circular by the government. It covers soft solders, precious metal solders and common brazing solders, giving properties and instructions for proper use. Circular 492, *Solders and Soldering,* is available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. at 15 cents a copy.

Workability of Magnesium Alloys Increased by Lithium Additions

Recent work at Dow Chemical Co. has shown that lithium additions of 3 to 16% increase the workability of magnesium-aluminum, magnesium-zinc and magnesium-aluminum zinc alloys. These results were reported in the *Journal of Metals* (July, 1950) by Robert S. Busk, Donald L. Leman and John J. Casey.

They found that magnesium-lithium-aluminum alloys have high strengths in the hardened state accompanied by extreme brittleness and lack of stability on heating at temperatures as low as 180 F. Magnesium-lithium-zinc alloys are similar except that they are less brittle. In certain magnesium-lithium-aluminum-zinc alloys, however, a combination of heat treating and cold rolling can be used to produce stable high-strength properties, with good elongation but low toughness.

Many of the alloys studied have properties superior to those of commercial magnesium alloys. The authors point out, however, that problems of temperature stability, brittleness, stress corrosion and low toughness at

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News Digest

intermediate strengths must be solved prior to further development of these alloys.

Polarized Light Employed

Plastic deformation of metals can now be studied by polarized light, using a technique developed by D. H. Woodard, of the National Bureau of Standards. Polarized light shows up differences in orientation resulting from deformation of fully annealed specimens.

The method, described in Technical Report 1433, has been used only on Monel but is expected to find application in studies of plastic deformation in other metals.

Pressure Welding Investigated

An investigation of the pressure-welding characteristics of copper-base alloys, carried out by Edwin Davis and Eric Holmes, was described in the British *Journal of the Institute of Metals* (May, 1950). The study was the result of increasing interest in pressure welding which, properly controlled, produces joints superior to those of other welding processes.

Adopting as the criterion of weldability the minimum deformation required to produce maximum joint strength, the copper-base alloys were found to rank in the following order of decreasing weldability: deoxidized copper; 70-30 and 80-20 cupro-nickel; 93-7 and 91-9 phosphor bronze; 85-15 brass; 60-40 brass; silicon bronze and aluminum bronze. In the case of aluminum bronze, all failures on tensile testing occurred through the weld.

French Steel Output Increased

An indication that France is rapidly regaining her position among the great industrial powers of the world is provided by a recent report on steel output.

During 1949, France produced a

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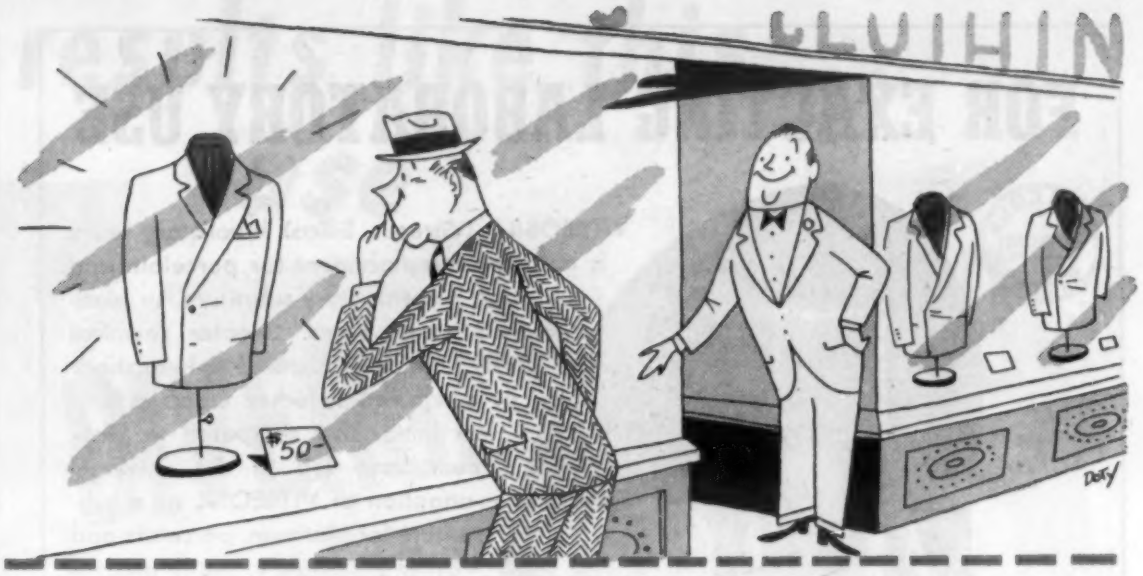

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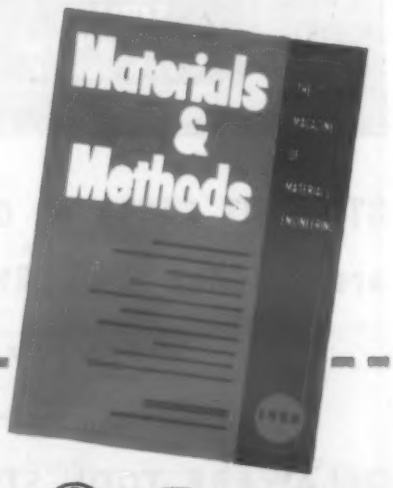

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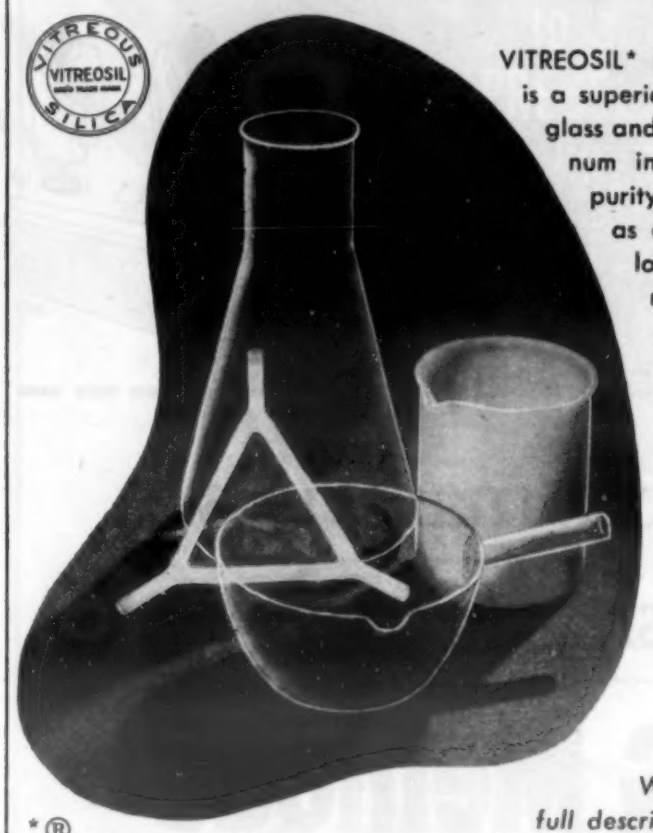

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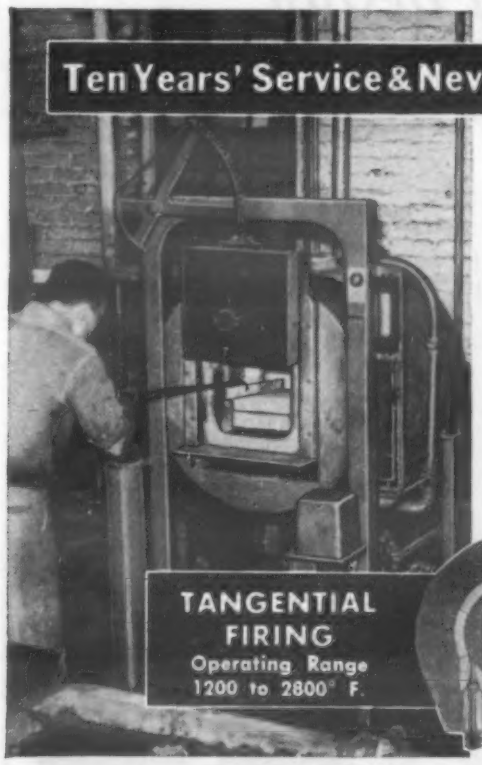

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News Digest

monthly average of 760,000 tons of crude steel (ingots and castings) and 513,000 tons of finished rolled products. These figures represent increases of 26 and 20%, respectively, as compared with the monthly average for 1948, and increases of 46 and 49%, compared with 1938. France now ranks fourth in world steel production, behind the United States, the U.S.S.R. and Great Britain.

Low Temperatures Improve Aluminum

Most of the important properties of aluminum alloys are either unaffected or improved by low service temperatures, a recent report shows.

A review of the available sources of data on the mechanical properties of aluminum alloys at low temperatures and a summary of the material provided in each source has been published by the National Advisory Committee for Aeronautics. From this data, the authors of Technical Note 2082, K. O. Bogardus, G. W. Stickley and F. M. Howell, have drawn several general conclusions regarding aluminum alloys used commercially in this country.

Generally, as temperature decreases:

1. Tensile and yield strengths of aluminum alloys increase. This improvement is greater for wrought alloys than for cast alloys.
2. Wrought alloys show improved elongation, while cast alloys show either a slight increase in elongation or no appreciable change.
3. Reduction of area decreases somewhat.
4. Modulus of elasticity increases.
5. Hardness increases.
6. Notch sensitivity, as measured by the usual types of impact tests, is not adversely affected.
7. Fatigue strength increases.

Steel Specifications Ready

ASTM specifications for steel flat products, dated March 1950, are now available in a 204-page book. These

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Steel Gears—Case History

PROBLEM: To remove oil, greases and shop dirt from gears prior to heat treatment and to descale the gears after heat treatment without hydrogen embrittlement and with a minimum of dimensional change. Complete de-rusting of various iron and steel shapes also had to be considered.

PREVIOUS PROCESS: A highly caustic cleaner for the removal of oils and greases. Raw acid for general rust and scale removal. Wire brushing for the removal of heat scale and discoloration from gears susceptible to hydrogen embrittlement and whose dimensional tolerances were very small.

PRESENT PROCESS: Diversey No. 909 for oil and grease removal and Diversey Everite for all descaling and de-rusting operations.

RESULTS: Diversey No. 909 produced decidedly cleaner surfaces than the previously used material and did it in less time! The heat treated work contained no burned oil residues.

The gears which could not be pickled previously due to tendencies for hydrogen embrittlement are safely descaled with Diversey Everite. Wire brushing operations have been eliminated. No attack occurs on the gears in spite of the fact that prolonged pickling is required to remove the heavy scale at the root of the gear teeth. And Everite produces brighter surfaces than were previously obtainable with any method.

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ENGINEERING B-W PRODUCTION

News Digest

specifications are reprinted from the 1949 Book of ASTM Standards. Copies can be obtained from the American Society for Testing Materials, 1916 Race St., Philadelphia 3, at $2.25 each.

News of Engineers

Jerome F. Kuzmick has resigned from the position of manager of the Metal Powder Dept. of Ekstrand & Tholand, Inc. to become president of Welded Carbide Tool Co., Inc. In addition to this new post, Mr. Kuzmick is continuing his activities in the powder metallurgy field in a consulting capacity, with headquarters at 4 Marquette Rd., Upper Montclair, N. J.

The election of *William F. McConnor* as executive vice president of the National Tube Co., subsidiary of United States Steel Corp., has been announced. *H. J. Wallace* succeeds Mr. McConnor as vice president in charge of sales.

Andrew Liston has been named manager of the Hydraulic Turbine & Marine Products Dept. of The Baldwin Locomotive Works. He formerly served as sales manager of this department.

Two new members were elected to the board of directors of E. F. Houghton & Co. They are *D. C. Miner*, advertising manager of the Company, and *William K. Barclay*, of Stein Bros. & Boyce.

Hamilton Merrill recently was elected president of Manning, Maxwell & Moore, Inc. *Charles H. Butterfield* assumes Mr. Merrill's former position as vice president in charge of the Consolidated-Ashcroft-Hancock Div.

Carnegie-Illinois Steel Corp. has announced the promotion of *Milton L. Weislogel* to the position of assistant to the general superintendent of the Gary Steel Works of this United States Steel Corp. subsidiary. *Frank A. Kelly* succeeds Mr. Weislogel as plant industrial engineer.

M. W. Sledge has been named to replace the late E. W. Stephen as manager of the Belt Sales Dept. of the Goodyear Tire & Rubber Co. *H. R. Harrington* was appointed to replace Mr. Sledge as assistant manager.

The election of *Francis Thomas* as vice

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"We tuned-out habit-itis and a new TV sales star was born"

Phenolic component of Lightning Arrester molded of Monsanto's Resinox by Teal Molding Company, New Haven, Conn., for JFD Manufacturing Co., Inc., Brooklyn, N. Y.

says Julius Finkel, President, JFD Manufacturing Co., Inc., Brooklyn, N.Y.

"We discovered the TV *sales hit* of 1950," continues Mr. Finkel, "when we rang the bell on habit-thinking in our plant–and engineered a new television antenna with built-in Lightning Arrester to protect TV sets against lightning and static charges."

The insulating parts of these built-in "sales boosters" are molded of a new Resinox phenolic material made by Monsanto. It combines superior electrical properties with excellent moldability and fast curing.

This is just one of the job-fitted formulations in which Resinox is manufactured to contribute properties such as low moisture absorption, high heat resistance, low dielectric constant and power factor. Intricate parts–large or small–are molded in fast, mass-production techniques... at exceedingly low cost.

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News Digest

president of Orinoco Mining Co., a subsidiary of the United States Steel Corp., has been announced. Mr. Thomas resigned as vice president of S. J. Groves & Sons in order that he might accept this new position.

Angus G. Sturrock has been appointed manager of the Metallurgical Div. of Wyckoff Steel Co. His headquarters will be located in Chicago. *Edsel Bishop,* formerly of Carnegie-Illinois Steel Corp., joined the Company as metallurgist for the Ambridge, Pa., plant, succeeding the late Howard M. Smith.

Carboloy Co., Inc. has named *Kenneth R. Beardslee* president and member of the board of directors of the Company. Mr. Beardslee, formerly vice president and marketing manager for Carboloy, succeeds the late Walter G. Robbins. At the same time, *Eugene F. Wambold,* vice president in charge of manufacturing, was promoted to the newly created post of executive vice president in charge of manufacturing, engineering, employee and community relations, and purchasing. He was also appointed to the Carboloy board of directors.

R. T. Adams has been promoted by the Lima-Hamilton Corp. to the position of sales manager for the Hamilton-Kruse line of can-making. He succeeds *Roland H. Johnson,* who resigned from Lima-Hamilton to join the Standard Knapp Div. of Hartford Empire Co.

Battelle Memorial Institute has announced the addition of several members to its staff. *Charles S. Peet* will do research on the engineering properties of materials. *L. L. Marsh, Jr.* will be engaged in research on engineering materials. And *Wilbur J. Wilson* will conduct research on nonferrous metals.

A. W. Sawyer has been promoted to the position of assistant to the vice president of The Lincoln Electric Co. He previously was in charge of the development and production of welding instruction aids.

Phelps Dodge Copper Products Corp. has elected *Daniel F. McGlinchey* a vice president of the Corporation.

Dr. *Edwin O. Barstow,* vice president of The Dow Chemical Co., recently observed his 50th anniversary with the Company. His association with the Company's magnesium development has been such that he has been referred to as the "father" of the American magnesium industry.

Non-Ferrous Permanent-Mold, Inc. has named *T. S. Roderick* as general manager, with headquarters at the Company's offices in Mansfield, Ohio.

George Carleton, Jr. was recently elected president of the Nice Ball Bearing Co. Mr. Carleton, formerly executive vice presi-

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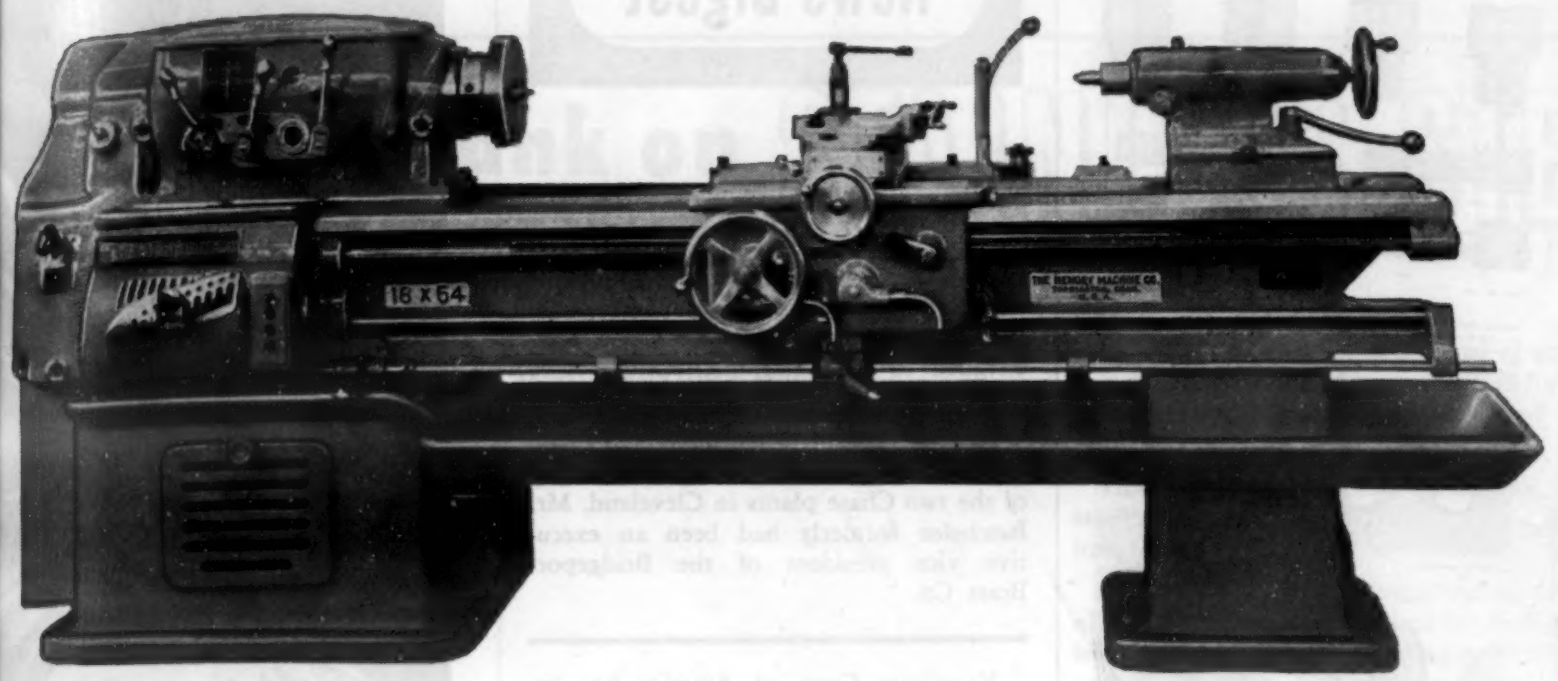

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The Hendey Machine Company, Torrington, Connecticut, found the induction method best for lathe bed ways that must retain accuracy. Their engineers specify a 1¼ per cent nickel alloy cast iron, induction-hardened to provide a minimum reading of 70 on the Shore scleroscope (about 500 BHN). Distortion never exceeds 0.012" in a 6-foot length of this nickel cast iron, and the depth of the hardened skin runs as high as 3/32".

Nickel in cast iron lowers the critical transformation range, thus promoting greater depth of hardness than in plain iron, and minimizing distortion. Moreover, there is gradual blending of the hardened layer into the softer pearlitic interior, whereas in unalloyed iron the transition zone is apt to be completely graphitized and hence extremely weak.

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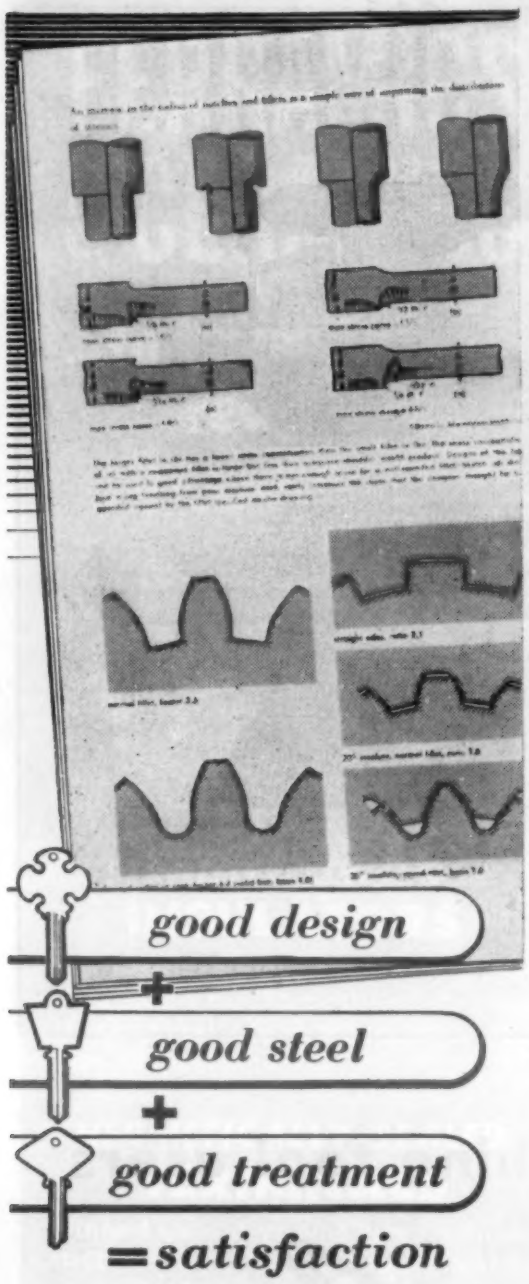

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News Digest

dent, succeeds *Walter H. Rossmassler,* who is retiring.

Allis-Chalmers Manufacturing Co. has named *Mert M. York* as manager of its Boston district office. Mr. York had been assigned to the Charlotte, N. C., office since joining Allis-Chalmers.

Mead W. Batchelor has joined the Chase Brass & Copper Co., Inc. as works manager of the two Chase plants in Cleveland. Mr. Batchelor formerly had been an executive vice president of the Bridgeport Brass Co.

Vanadium Corp. of America has announced the sudden death of *Richard G. McElwee,* manager of its Iron Foundry Div. Mr. McElwee had been associated with Vanadium for 15 years.

Nathan Lester, president of the Lester Engineering Co. and Lester-Phoenix, Inc., died of a heart attack at his home in Cleveland.

Hanson-Van Winkle-Munning Co. has announced the death of *Edward Leo Gann,* well-known as one of the outstanding practical electroplating experts of America.

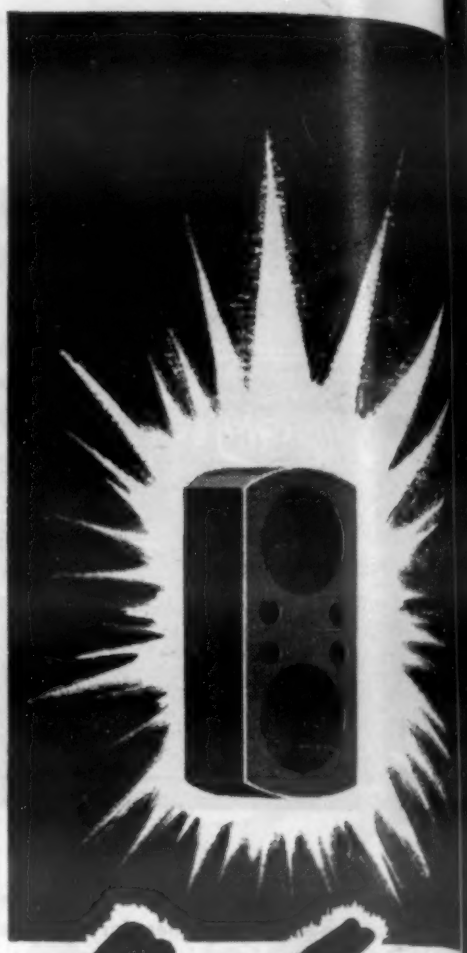
Andrew Czapak, chief engineer of the Volco Brass & Copper Co., died suddenly at his home in Elizabeth, N. J.

News of Companies

Announcement has been made of the formation of the *David E. Long Corp.,* with offices located at 220 E. 42 St., New York 17. The Company will make and sell corrosion-abating materials and systems, and offer recommendations that will provide practical solutions of specific problems.

For the first time in its 40-odd year history, *Continental Foundry & Machine Co.,* East Chicago, Ind., has entered commercial weldery as an adjunct to its steel foundry production and manufacture of complete rolling mills, heavy machinery, and iron and steel rolls. The main purpose of the plant will be to produce fabricated steel and composite steel casting, and steel plate structures to effect economies in both weight and cost of intricate assemblies.

(Continued on page 160)



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Speer has been manufacturing components for more than 50 years, and is equipped to mold, extrude, or machine them to your specifications. Consult Speer if you are faced with a parts problem—there is no obligation.

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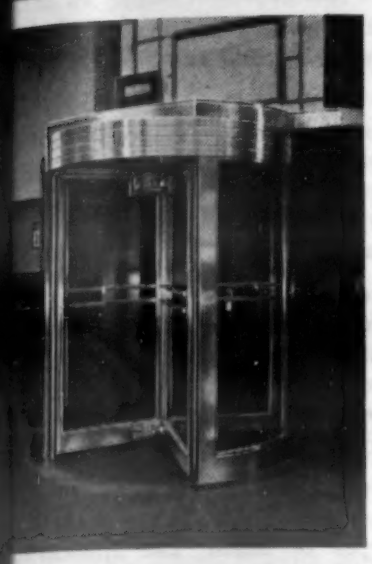

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The proven low maintenance cost of stainless steel was a primary reason for its selection for application in the Pelham Parkway Branch of The Bronx Savings Bank.

In this gem of a neighborhood bank, the stainless steel, buffed to a satin finish, gives a pleasing and luxurious appearance.

Stainless steel is also outstanding for its adaptability to architectural forms for both exterior and interior applications, including such a wide variety as curtain walls, window frames, grill doors, ornamental trimmings, and even tiny screws.

To insure the production of consistently high grade stainless steel, the use of ferro chromium of dependable quality and precise analysis is of prime importance. Vancoram Brand Ferro Chromium, made by closely controlled processing methods from carefully selected raw materials, fills these requirements. Low-carbon grades for the manufacture of stainless steel are supplied with a carbon content from 0.06% max. to 2.00% max., all containing from 67% to 72% chromium.

If you have a technical problem involving the making, treatment, fabrication, properties, or performance of stainless steel, our metallurgical engineers will be glad to help you solve it.

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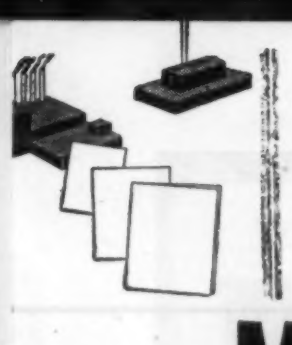


MANUFACTURERS' LITERATURE

Materials

Iron • Steel

Special Steels. Allegheny Ludlum Steel Corp., 8 pages, illustrated, No. 1a/1. Properties of this company's stainless, electrical, silicon and tool steels, magnetic materials and "Carmet" carbide metals. (1)

Steel Design. Climax Molybdenum Co., 72 pages. Booklet entitled "3 Keys to Satisfaction" tells how to combine good design, high quality steel and proper treatment for best results with steel components. (2)

Stainless Steels. Peter A. Frasse & Co., Inc., No. 5. Technical data on "Resistance to Sensitization of Extra Low Carbon Stainless Steels." Gives results of comparative tests on types 302, 304, 316, 321, 347 and 304 ELC steels for corrosion resistance after welding. (3)

Highly Machinable Steel. Jones & Laughlin Steel Corp. Booklet describes J & L "E" Steel, giving properties, grades and their equivalents, and applications. Steel said to have high machinability, give better finishes and extend tool life. (4)

Steel Bars. La Salle Steel Co. How Stressproof cold-finished carbon steel bar cuts costs because of strength, machinability, wearability and minimum warpage. (5)

Clad Steels. Lukens Steel Co., 68 pages, illustrated. Compositions, mechanical properties, corrosion ratings and applications of nickel-clad, stainless-clad, Inconel-clad and Monel-clad steels. (6)

Heat Treatment of Steel. Republic Steel Corp., 55 pages, illustrated, No. 540-5M. Detailed discussion of the heat treatment of steel, giving basic theory and descriptions of the important heat treating methods. Includes mechanical properties of alloy steels and data and reference charts. (7)

Alloy Steel. Joseph T. Ryerson & Son, Inc., 2 pages. Describes Ledloy, a lead-bearing, open-hearth steel that machines from 30 to 50% faster than the fastest cutting screw steel previously available. Has good ductility, strength and case-hardening qualities. (8)

Forging Steels. Timken Roller Bearing Co., Steel & Tube Div., 112 pages. Entitled "Evaluating the Forgeability of Steels," booklet provides detailed forging data of use in design work. (9)

Alloy Steels. Wheelock-Lovejoy & Co., Inc., 3 pages. Presents data including composition limits, heat treating instructions, physical properties, sizes, applications, etc., for AISI, Hy-Ten and SAE alloy steels. (10)

Nonferrous Metals

Aluminum and Its Alloys. Aluminum Co. of America, 154 pages, illustrated, No. AD51. Comprehensive data on properties of aluminum and its alloys, heat treatment of wrought alloys, forms available, alloy castings and their design, and various fabricating practices. (11)

Pre-Finished Metals. American Nickeloid Co. Data folder on properties, tempers and finishes of pre-finished metals available in brass, zinc, aluminum, copper and steel bases. Specifications listed. (12)

Low Melting Alloys. Cerro de Pasco Copper Corp., 40 Wall St., New York 5, N. Y. Loose-leaf binder and informative engineering literature on Cerro (low temperature melting) alloys and special applications useful in many phases of manufacturing. Free when requested from Cerro de Pasco on company letterhead.

Spring Alloy. Elgin National Watch Co., Industrial Products Div., 2 pages. Composition and properties of cobalt-chromium-base spring alloy, Elgiloy, having high corrosion, set and fatigue resistance, hardness and elasticity. (13)

Electrical Contact Materials. Fansteel Metallurgical Corp., 36 pages, illustrated. Fundamental notes on contact design, and properties, advantages and principal uses of Fansteel electrical contact grades. Also discusses assembly methods, including riveting, spinning, upsetting, spot and projection welding, and brazing. (14)

Laminated Metals. General Plate Div. of Metals & Controls Corp., 4 pages, illustrated, No. 1a. Characteristics and uses of various laminated metals, including precious metals overlays and laminated silver contacts. (15)

Welding Nickel Alloy. Illium Corp., 4 pages, No. 105B. Instructions for metallic arc and oxyacetylene gas welding of Illium, nickel-base corrosion resisting alloy. (16)

Monel Properties. The International Nickel Co., 23 pages, illustrated, No. T-4. Detailed engineering properties of "K" and "KR" Monels, including physical and mechanical properties, temperature effects on strength, working characteristics, heat treatment, corrosion resistance, mill products, specifications and applications. (17)

Electrical Resistance Alloy. The C. O. Jelliff Manufacturing Co., 6 pages. Graphical and tabular engineering data on Jelliff Alloy 1000, a new electrical resistance alloy with outstanding mechanical and electrical properties. (18)

Bronze Bearing Material. National Bearing Div., American Brake Shoe Co. Describes physical properties, operating characteristics and bar types and sizes of "Tiger" bronze bearing material. (19)

Bronze Bars. Randall Graphite Bearings, Inc., illustrated, No. 101. Dimensions of this company's complete stock of bored and solid bronze bars for bearing manufacture. Includes brief specifications and description of manufacturing process. (20)

Aluminum Alloys. Reynolds Metals Co., 12 pages, illustrated. Gives fabrication information, types of finish, and applications and properties of this company's aluminum alloys. Gives specifications of sheet and plate, wire, rod and bar, tubing and pipe, structural and extruded forms. (21)

Nonmetallic Materials • Parts

Porcelain Insulators. The Akron Porcelain Co., 6 pages, illustrated. Folder illustrates numerous porcelain insulating parts made from unglazed white and gray, glazed, communication and refractory porcelains. Includes brief description of engineering properties of porcelain. (23)

Felt Samples. American Felt Co., 8 pages. S.A.E. felt standards and specifications, with samples exhibiting 16 different grades. (24)

Hard Rubber and Plastics. American Hard Rubber Co., 60 pages, illustrated. Complete technical data on all grades of Ace hard rubber and plastics. (25)

Ceramics. American Lava Corp., 4 pages, No. 248. Chart of mechanical and electrical properties of AlSiMag ceramics. (26)

Rubber Parts. Automotive Rubber Co., Inc. Series of bulletins dealing with the use of rubber for industrial equipment and production parts to give insulation or prevent corrosion. (27)

Glass Fiber Sleeving. Bentley, Harris Manufacturing Co., 4 pages. Describes new Fiberglas tubing and sleeving with high physical and dielectric properties, available at a price comparable to that of ordinary insulations. Samples included. (28)

Phenolic Molding Compounds. The Borden Co., Chemical Div. Catalog describes wide range of Durite phenolic resins said to have high heat-, electrical- and impact-resistance. Indicates possible modifications available upon order. (29)

Ceramic Bodies. Centralab Div., Globe-Union, Inc., 28 pages, illustrated, No. 720-10M. Comprehensive survey of this firm's ceramic production. Includes description of engineering properties of ceramics, design

To obtain literature appearing on these pages, please refer to easy-to-use reply card on page 157.

MANUFACTURERS' LITERATURE

information, allowable tolerances, and indicates broad scope of ceramic products with data and dimensions. (30)

Porcelain Products. The Colonial Insulator Co., 12 pages, illustrated. Shows wide range of porcelain products, including insulators, forms for dipped rubber goods, kitchen and soda fountain appliances, and art products, all made to customers' specifications. (31)

Precision Molded Plastics. Consolidated Molded Products Corp., 8 pages, illustrated. Describes this company's facilities, experience and equipment for producing compression-, transfer- and injection-molded plastics. (32)

Plywood. Douglas Fir Plywood Assn., 32 pages, illustrated. Series of articles show how to use plywood effectively in fixtures, displays, posters and signs. (33)

Plastic Resin. Dow Chemical Co., Plastic Div., 8 pages, illustrated. Presents complete data on Saran, a plastic resin for injection molding. (34)

Plastic News. Durez Plastics & Chemicals, Inc. Monthly *Durez Plastics News* presents many ideas and applications for plastics users. (35)

Inert Resin. E. I. du Pont de Nemours & Co., Inc., 12 pages, illustrated. Detailed description of "Teflon," highly inert resin with zero water-absorption. Lists physical properties and indicates use as gaskets and packings with detailed design information for each application. Includes tables, charts and case histories. (36)

Flexible Tubing. Flexible Tubing Corp., 8 pages, illustrated, No. 5-4. Applications and performance data on Spiratube, flexible tubing for ventilation and materials conveying. (37)

Laminated Thermosetting Plastics. The Formica Co., 16 pages, illustrated, No. 1b/9. Descriptions and properties of various Formica grades. Includes glass fibre, silicone, chemical-resistant synthetic fibre, cotton mat, arc-resistant and special punching grades. (38)

Polyvinyl Resin. B. F. Goodrich Chemical Co. Technical details on Geon, a versatile, heat-, weather-, wear- and chemically-resistant resin available in transparent, translucent or opaque forms for a wide variety of uses. (39)

Cellular Rubber. Great American Industries, Inc., Rubatex Div., No. RBS-12-49. Catalog indicates gasketing, cushioning, shock-absorbing and vibration damping applications of Rubatex, a closed cell rubber generally available in sheet form and made from either natural or synthetic rubbers. (40)

Corrosion Resistant Equipment. Haveg Corp., No. F-6. Detailed engineering data on Haveg, strong, lightweight molded material with high corrosion resistance. Includes numerous applications. (41)

Glass Products. McKee Glass Co., 16 pages, illustrated, No. 12-68. Describes types of glasses manufactured, their applications and facilities for large-scale production. Illustrates numerous products for home and industry, including electrical, laboratory, television and marine equipment. (42)

Phenolic Resin. Monsanto Chemical Co., Plastics Div. Information on Resinox, a phenolic resin combining high dielectric strength with excellent moldability and rapid curing. Enables mass-production of intricate, heat resistant parts at low cost. (43)

Electrical Porcelain. National Electrical Manufacturers' Assn., 20 pages, illustrated. Detailed information on the composition, manufacture and chemical, electrical and physical properties of electrical porcelain products. (44)

Laminated Plastic. National Vulcanized Fibre Co., 16 pages, illustrated, No. lb/12. Physical, electrical, mechanical and chemical properties of Phenolite laminated plastic sheet, rods, tubing and special shapes. Properties of National Vulcanized Fibre also listed. (45)

Refractory Cements. Norton Co., 16 pages, No. 863. Properties, selection and application data useful for choosing the appropriate cement for particular refractory requirements. (46)

Fabricated Resinous Material. Panelyte Div., St. Regis Sales Corp., 8 pages, illustrated. Description, properties and uses of Panelyte, a paper-, fabric-, fibre-glass- or asbestos-base material available in sheets, rods, tubes, molded forms and fabricated parts. Industries using Panelyte include chemical and metal finishing, aviation, radio, automotive, textile and marine. Includes specifications. (47)

Nonmetallic Fabricating Services. Rogers Corp., Fabricating Div., 8 pages, illustrated. Describes this company's services in custom fabricating plastics and fibrous materials. Includes design considerations for using fibrous materials and lists materials available for fabrication. (48)

Acrylic Molding Powders. Rohm & Haas Co., Dept. MM, Washington Sq., Philadelphia 5, Pa., 16 pages, illustrated. Summary of up-to-date information in Plexiglas molding powders, giving physical properties and suggested applications of specific powders to such jobs as molding industrial parts, signs and sign letters, household decorations and accessories. Free when requested from Rohm & Haas on company letterhead.

Sponge Rubber. Sponge Rubber Products Co., 12 pages, illustrated. Specifications and descriptions of products made from Spongex, including sheet sponge rubber, die cut shapes, cord, tubing, strips, molded forms and pad stock. (49)

Silicone Rubber Parts. Stalwart Rubber Co. Complete information on silicone rubber parts capable of withstanding extreme temperature variations, chemical attack by numerous materials, and permanent compression. (50)

Molded Ceramics. Star Porcelain Co., 15 pages, illustrated. Technical descriptions and specifications for a wide variety of molded ceramic products. (51)

Vitreous Silica Ware. The Thermal Syndicate, Ltd. Bulletins give description of complete line of Vitreosil laboratory ware said to have greater chemical purity and higher resistance to heat shock than other ceramics, and a low initial cost compared to platinum. (52)

Rubber Parts. Tyer Rubber Co., 4 pages, illustrated, No. 1c. Describes design and molding service for rubber parts specified by industry. (53)

Carbon Brushes. The United States Graphite Co., 40 pages, illustrated, No. B-49. Detailed catalog gives types of brushes; tables of their physical characteristics; types of connections, shunts and terminals; specification requirements for custom brushes; and directions for ordering brushes. Also describes plant operations and definitions of brush characteristics. (54)

Polyester Resins. U. S. Rubber Co., Naugatuck Chemical Div., 18 pages. Detailed properties and applications of Vibrins, thermosetting polyester resins. Fabricating information includes details on pressure laminating and casting. Price schedule included. (55)

Plastics Parts. Watertown Manufacturing Co., 44 pages, illustrated. Complete data on properties and applications of plastics produced by this company. (56)

Refractory Shapes. Western Gold & Platinum Works, Ceramic Div., 1 page, illustrated, No. 224. Gives physical constants and some applications of Wesgo Super Refractory, an exceptionally resistant material to thermal shock. Available in stock shapes or as specified by customers. (57)

Fabricated Wood. Woodall Industries, Inc., 16 pages, illustrated. Facilities for custom fabrication of industrial Masonite, versatile material that can be used more advantageously than wood, plywood, sheet metal or paper stock boards in many applications. (58)

Metal Parts • Forms

Aluminum Impact Extrusions. Aluminum Co. of America, 2144-J Gulf Bldg., Pittsburgh 19, Pa. Full explanation of Alcoa's impact extrusion process showing advantages and wide range of possible shapes. Booklet available when requested from Alcoa on company letterhead.

Aluminum Parts. Aluminum Goods Manufacturing Co., 56 pages, illustrated. Comprehensive catalog covers this company's extensive facilities for producing aluminum parts, the technical services available and a wide range of products. (59)

Stainless Steel Parts. Amplex Manufacturing Co. (Div. of Chrysler Corp.), 1 page, illustrated. Describes bearings, finished machine parts and permanent filters made from Oilite stainless steel. (60)

Precision Castings. Austenal Laboratories, Inc., Microcast Div., 16 pages, illustrated. Large variety of applications for Microcast precision castings pictured and described. Process advantages and design factors discussed. (61)

Heat Exchanger Tubes. The Babcock & Wil-

MANUFACTURERS' LITERATURE

cox Tube Co., 6 pages, illustrated, No. TB-329. Specifications, chemical analyses and mechanical properties of this company's grades of seamless and welded steel heat exchanger and condenser tubing. Includes table of size ranges and general application data. (62)

Beryllium Copper Springs. The Beryllium Corp. Details on beryllium copper, a corrosion and fatigue resistant, high elastic strength spring material with good formability and electrical properties especially adaptable for instrument springs. (63)

Magnesium. Brooks & Perkins, Inc., illustrated. Folder gives table of magnesium alloy characteristics, design information, and lists this firm's magnesium products. (64)

Stainless Tubing. Carpenter Steel Co., Alloy Tube Div., 4 pages, illustrated. Physical properties, corrosion resistance and available sizes of this company's stainless steel tubing. (65)

Stainless Valves. The Cooper Alloy Foundry Co., 48 pages, illustrated. Catalog gives complete line of this firm's Cooper Alloy stainless valves, fittings and accessories. Includes full design information and drawings. (66)

Magnesium Die Castings. Doehler-Jarvis Corp., 4 pages, illustrated. Describes Doler-Mag magnesium die castings, giving physical properties, data on weight savings, typical applications and numerous advantages. (67)

Forgings. Drop Forging Assn., 60 pages, illustrated. Booklet entitled "Metal Quality" describes economic, engineering and production advantages obtainable through the use of forgings. (68)

Aluminum and Magnesium Casting. Eclipse-Pioneer Div. Foundries. "Book of Facts" describes modern machines, techniques, and testing devices for rapid, economical aluminum and magnesium casting. (69)

Heat Resistant Castings. Electro-Alloys Div., American Brake Shoe Co., 57 pages, illustrated, No T-155. Describes this company's metal fabrication facilities from research to final testing. Gives detailed properties of Thermalloy and Chemalloy heat, abrasion and corrosion resistant alloys, and shows numerous applications. (70)

Investment Castings. Engineered Precision Casting Co., 4 pages, illustrated. Describes Epco precision investment castings. (71)

Steel Tubes. Globe Steel Tubes Co., 8 pages, illustrated, No. 1a/12. Specifications and tolerances for this company's seamless and Gloweld-welded tube and pipe of carbon, alloy and stainless steel, and of Globe-iron. (72)

Self-Lubricating Bushings. Graphite Metallizing Corp., 8 pages, illustrated, No. 108. Characteristics and uses of Graphalloy self-lubricating bushings. Clearances, materials selection and other design data given. (73)

Precision Castings. Gray-Syracuse, Inc., 4 pages, illustrated. Shows various small parts precision-cast of brass, bronze, beryllium, copper and carbon stainless, tool and high temperature steels. (74)

Zinc Die Castings. Gries Reproducer Corp., 4 pages, illustrated. Detailed specifications of Junior and Senior type GRC rust proof and corrosion resistant nonferrous zinc alloy wing nuts and a variety of small zinc die castings and injection moldings. (75)

Beryllium Copper Springs. Instrument Specialties Co., 12 pages, illustrated, No. 6. Catalog gives advantages and typical applications of Micro-Processed beryllium copper springs and electrical contacts with design suggestions and price list. Includes properties and hardening information on beryllium copper. (76)

Aluminum Cable. Kaiser Aluminum & Chemical Corp. Detailed information on physical and electrical properties of Kaiser Aluminum ACSR and All-Aluminum Cable. Includes tables of available reel sizes. (77)

Cemented Carbide. Kennametal, Inc., 2 pages, illustrated, No. 284. Reports high temperature performance of tube fabricated from Kentanium K140A, new heat resisting, cemented titanium-carbide. (78)

Stainless Castings. Lebanon Steel Foundry. Data sheets provide technical information on stainless steel castings specifically designed to meet numerous, highly corrosive service conditions. (79)

Forgings and Pressings. Lenape Hydraulic Pressing & Forging Co., 60 pages, illustrated, No. 9-49. Catalog of welding necks, manways, curved nozzles and pads and miscellaneous forged and press-formed parts. (80)

Aluminum Extruded Shapes. Light Metals Corp., 6 pages, illustrated. Shows a variety of aluminum fabrications and extruded shapes, and facilities to produce these shapes to meet customers' specifications. (81)

Gray Iron Castings. Meehanite Metal Corp., 8 pages, illustrated, No. 31. One of a series of applications and engineering data booklets on casting. Shows specific applications for Meehanite gray iron castings. (82)

Powder Metallurgy Glossary. Metal Powder Assn., 4 pages, No. 9-50T. Gives a list of definitions of terms tentatively set up as standards in powder metallurgy and subject to annual revision. (83)

Nonferrous Powder Parts. The New Jersey Zinc Co. Booklet entitled "Applications and Properties of Nonferrous Powder Parts" includes 14 case histories showing cost savings and properties of commonly used brass powders. (84)

Precision Castings. Ohio Precision Castings, Inc., illustrated. Brochure on job study demonstrates production savings through application of Ohio precision plastic mold castings available in brass, bronze, aluminum or beryllium copper. (85)

Spun Shapes. Phoenix Products Co., Metal Spinning Div., 4 pages, illustrated. Describes Phoenixspun method for producing spherical and extra deep-drawn contours in various diameters, and in hard metals up to ⅜-in. thickness. (86)

Powdered Metal Parts. Powdered Metal Products Co. of America. Booklet describes developments in powder metallurgy leading to new applications for Powdermet parts. Includes descriptions of copper filling process, permitting economical production of parts previously almost impossible to make. (87)

Stainless Steel Products. Schnitzer Alloy Products Co., 48 pages, illustrated, No. 50. Catalog gives sizes and specifications of large variety of stainless steel products such as machine screws, cap screws, nuts, pipe and tubing, sanitary fittings and tools, flow glasses, and bar, plate and sheet stock. Includes laboratory corrosion data on numerous corrosive materials. (88)

Spun Parts. Spincraft, Inc., No. 3. Data book on metal spinning and fabrication, giving useful information for designers and indicating some of the results obtainable through metal spinning. (89)

Stainless Steel Castings. The Stainless Foundry & Engineering Co., 4 pages, illustrated. Shows a variety of stainless steel castings, regulator and valve parts, centrifugal pump impellers, etc., and includes helpful engineering data. (90)

Powder Metal Parts. F. J. Stokes Machine Co., 4 pages, illustrated, *Stokes News*, Vol. 3, No. 3. Indicates some of the diverse applications of powder metal parts made in this firm's presses. (91)

Metal Tubing. Superior Tube Co., No. 31. Information on round and shaped tubing available in carbon, alloy and stainless steels and nickel alloys. Includes specifications and descriptions of processing. (92)

Spinning. Roland Teiner Co., Inc., 4 pages, illustrated. Describes this company's facilities for spinning and sheet metal working of all metals, including stainless steels. (22)

Seamless Tubing. Tube Reducing Corp., 16 pages, illustrated, No. R2. Describes Rockrite process for manufacturing tubing of numerous metals to close tolerances and high finishes. Also lists advantages enabling lower costs in machining, and indicates shapes, sizes and forms of tubing available. (93)

Steel Castings. Unitcast Corp., illustrated, No. 649-S. Folder indicates this company's hardness, radiographic, chemical and microscopic testing facilities for insuring high quality castings. Includes information to aid in receiving quick estimate on any casting job. (94)

Coatings • Finishes

Metal Coatings. Allied Research Products, Inc. Describes Iridite chemical coatings for providing colored or bright finishes, paint bases or corrosion resistance for nonferrous surfaces. Includes information on addition agents for providing bright surfaces from zinc and cadmium plating baths and wetting agents for efficient pickling. (95)

Clear Lacquer. Maas & Waldstein Co., No. 110. Complete details on Dulac Clear Universal Lacquer No. 462, said to permit retention of desirable surface qualities of most metals, give good adhesion, and dry out of dust rapidly. (96)

MANUFACTURERS' LITERATURE

Micro-Hardness Indenter. Erb & Gray Co., 2 pages, illustrated. Describes MH indenter enabling microscopic determination of hardness of materials through use of diamond penetrator. Indicated uses include hardness testing of small parts, wire, heat treated areas of metals, organic materials and constituents in heterogeneous materials. Prices included. (148)

Thickness Gage. Ferro Enamel Corp. Folder gives complete details on pocket size thickness gage, enabling measurement of nonmagnetic coatings on ferrous surfaces to an accuracy of ±5%. (149)

Furnace Atmosphere Indicator. Claud S. Gordon Co., 2 pages, illustrated. Describes device which quickly indicates any deviation from desired furnace atmosphere. (150)

Microphotometer. Jarrell-Ash Co., No. 1-5. Specifications for Jaco projection comparator microphotometer, a flexible instrument offering many advantages to the spectrographer. (151)

Pyrometer Controller. Loudon Instruments, Inc., 5 pages, illustrated. Brief description of Loudon pyrometer controller for precise temperature control without a chart record. For such apparatus as heat treating equipment, die casting machines, and tinning and galvanizing pots. Includes operating principles, description of unit, case and accessories, and specifications. (152)

Spectrograph. National Spectrographic Laboratories, Inc., 4 pages, illustrated, No. 300. Describes NSL Spec-Power spectrograph having three standard type excitation units affording a discharge specifically suited to the quantitative or qualitative analysis required. (153)

Radium Radiography. Radium Chemical Co., 43 pages, illustrated. Detailed instructions on radiographic inspection of metal parts. Describes theory and advantages of, and safety procedures for radium use. Said to be especially advantageous for inspection of locations unattainable by X-ray apparatus. (154)

Testing Machines. Riehle Testing Machines Div., American Machine & Metals, Inc., 8 pages, illustrated, No. R-99. Brief descriptions of this company's universal, impact, tension, compression, transverse, torsion and hardness testing machines. Includes full line of precision accessories. (155)

Testing Instruments. Steel City Testing Machines, Inc., 4 pages, illustrated, No. G1248. Data on this company's hardness, universal, transverse, ductility, tensile, compression and hydrostatic testing machines includes capacities and dimensions. (156)

Pyrometer Indicator. Thermo Electric Co., 4 pages, No. 25. Technical features and prices of several models of pyrometer indicators for various temperature ranges. (157)

Control Instrument. Wheelco Instruments Co., 2 pages, illustrated, No. PO-1. Describes Wheelco Potentiotrol, sensitive electronic instrument affording close control of such conditions as temperature, speed, pressure and amperes. Includes specifications and price list. (158)

Hardness Tester. Wilson Mechanical Instrument Co., Inc. Information on Tukon Testers for micro-indentation hardness testing. Three models cover full range from micro to macro hardness testing, using loads from one gram to 50,000 grams. (159)

General

Powder Metal Presses. Kux Machine Co., illustrated. Catalog describes complete line of machinery for manufacturing wide variety of powder metal parts automatically and accurately. (160)

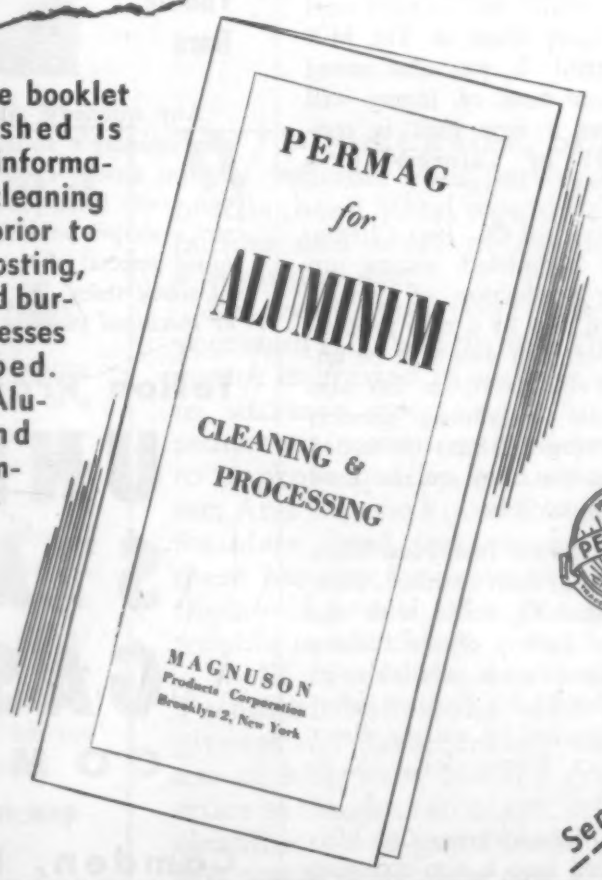
Chain and Belt Conveyors. Michigan Steel Casting Co., 8 pages, illustrated, No. 1-B. Bulletin describes and lists capacities of Misco rivetless chain conveyors and Woodman belt conveyors at elevated temperatures. (161)

Aluminum Cleaning. Magnuson Products Corp. Folder includes latest information on Permag cleaning and processing materials for aluminum. Covers hot tank immersion cleaning, metal washing machine cleaning, solvent cleaning, burnishing, frosting, etc. (65)

You Saw it Described in MATERIALS & METHODS

June issue page 123

This 12 page booklet just published is filled with information about cleaning Aluminum prior to finishing. Frosting, stripping and burnishing processes are described. Alloys of Aluminum and solvent cleaning are included.



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News Digest

The *C. H. Dutton Co.*, Kalamazoo, Mich., and *Hapman Conveyors, Inc.*, Detroit, have merged under the new name of *Hapman-Dutton Co.* In the reorganization, Henry W. Hapman was elected president and general manager, while Robert J. Brown became vice president, assistant general manager and treasurer.

A new open hearth shop will be built by *Inland Steel Co.* at its Indiana Harbor Works in East Chicago, Ind. The new facilities should be completed early in 1952, and will increase Inland's steel making capacity from its present rating of 3,750,000 tons to 4,500,000 net tons of ingots annually.

Sprague Electric Co., North Adams, Mass., and *Philips Industries, Inc.*, Hartford, Conn., have announced the formation of a new company, *Ferroxcube Corp. of America*, with headquarters to be located at 50 E. 41 St., New York City. It is expected that production quantities of Ferroxcube, a new ferro-magnetic ferrite particularly useful as a core material in high frequency coils and transformers, will be available this month. Officers of the new corporation include the following: Robert C. Sprague, president; John P. Adams, vice president in charge of sales; and T. James Reed, manager of the factory, located at Saugerties, N. Y.

Plans to increase steel production of the *Carnegie-Illinois Steel Corp.*, a subsidiary of *United States Steel Corp.*, Chicago 90, have been announced. Two coke oven batteries at the Gary Steel Works are to be rebuilt, while the stainless steel facilities at the Gary Sheet & Tin Mill are to be revamped. It was also stated that 700,000 more tons of ingots will be produced after a new mill is constructed in 1951 by Carnegie-Illinois near Trenton, N. J.

Welded Carbide Tool Co., Inc., Clifton, N. J., has just completed setting up facilities for the production of carbide powders, tools and dies by a new process. A new line of tools and dies will be announced soon. Welded Carbide has also inaugurated a die reclaiming service, wherein used drawing dies may be turned in and rebuilt so that they can be used again for the original job.

Young America Films, Inc., New York 17, has released a filmstrip entitled "How We Get Our Plastics", made with the cooperation of the *Society of the Plastics Industry*. The filmstrip is available in black and white for $3.50. Further information may be obtained by writing direct to Young America Films, Inc., 18 E. 41 St., New York 17.

Allis-Chalmers Manufacturing Co., Milwaukee, has entered into a non-exclusive

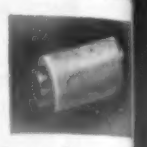
TEFLON!

The Plastic that's–

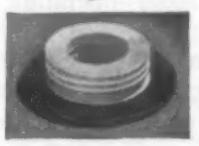
- ***Chemically Inert***
- ***Mechanically Tough***
- ***Heat-Resistant***
- ***Extremely Anti-hesive***

Non-corroding, non-contaminating Teflon was first spotted by USG as a revolutionary gasketing and packing material; we have always been foremost producers of Teflon gaskets and packings—solid, jacketed, impregnated, molded, machined, or combined with metals and other materials.

Next came utilization of Teflon's natural slipperiness—for bakery rolls, ink rollers, many other applications. USG Teflon rollers cut costs because they resist sticking, withstand heat, can't be wetted, are chemical-proof and easily cleaned.



Throughout industry, materials men are finding Teflon's unique combination of properties the answer to tough problems. Teflon expansion joints for corrosion-proof piping systems, Teflon diaphragms, pump cups, stopcocks, nozzles, Teflon insulators for high-frequency electrical equipment are just a few successful applications of Teflon fabricated by USG.



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Cylinders
Rods
Tubing
Bars

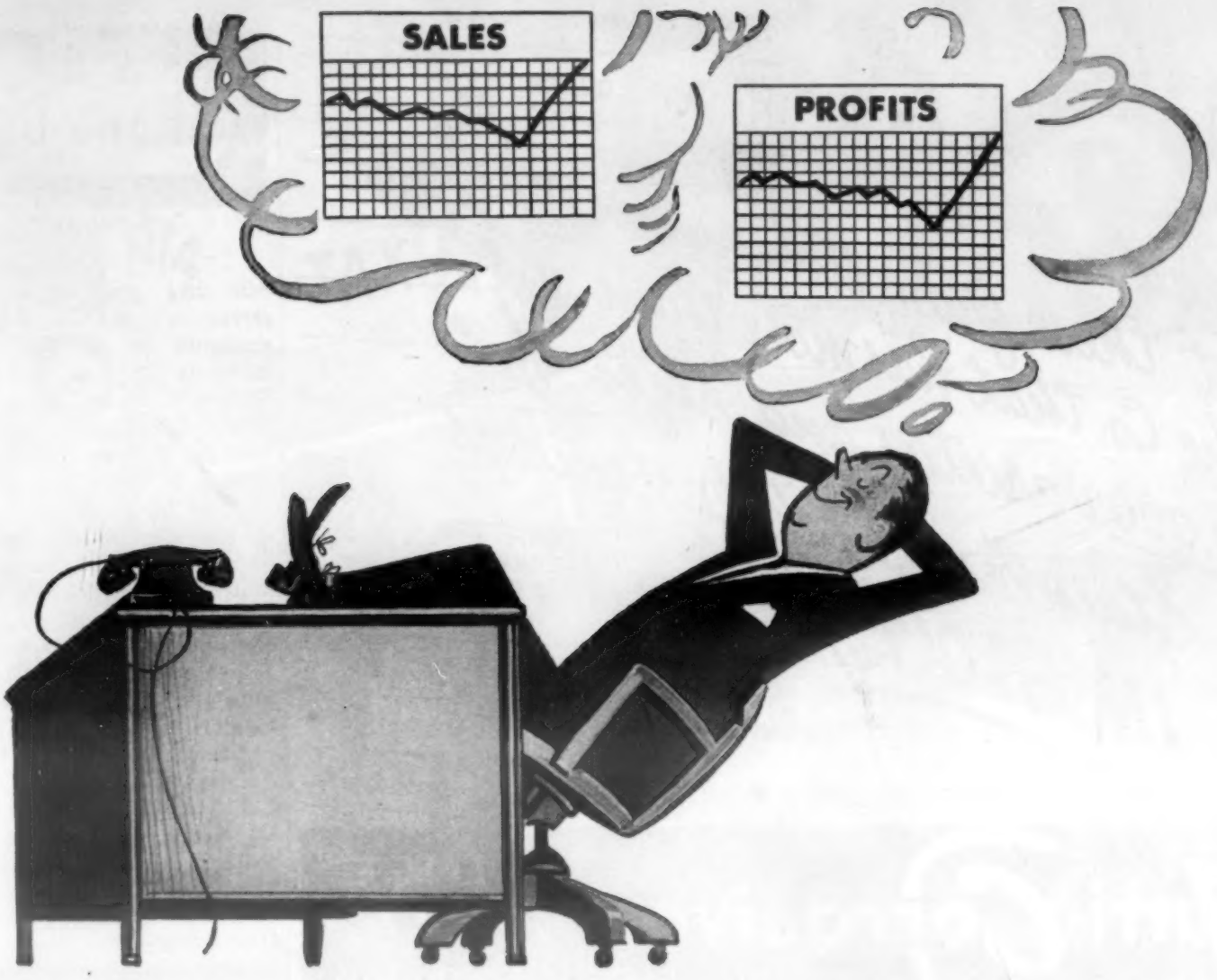
Any quantity, immediate delivery, from the country's most complete selection of Teflon stock. From our Teflon stock you can easily form parts needed, or if standard stock shapes and sizes are unsuitable, we'll mold special shapes or produce variations of stock sizes. *We also supply finished molded or machined parts exactly to your specifications.*

Teflon Products Division

UNITED STATES GASKET COMPANY

656 N. 10th St.

Camden, New Jersey



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The Allegheny Ludlum film library consists of a dozen or more lively, interesting motion pictures on the making and use of special steels—produced with sound and most in full color . . . just right for showing to company or business groups, technical meetings, etc. Films are loaned to you on request, without charge.

ADDRESS DEPT. MM-9

WE don't know, of course, whether your personal interest in Allegheny Metal would be that of a builder and seller of equipment—or a buyer and user.

But we *do* know you're interested in your own sales and profits. That means you're interested in ways to cut costs; to increase operating efficiency; to reduce maintenance and depreciation; to improve quality, add sales appeal, etc. And we *also* know that Allegheny Stainless Steel can secure some of these benefits for you—perhaps all of them—if you'll take the time and trouble to check up.

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agreement with the *Picker X-Ray Corp.*, New York City, covering the sales and service of Allis-Chalmers' betatrons for both medical and industrial applications.

Production of plastics has commenced at the new Kalamazoo, Mich., plant of the *Panelyte Div.* of *St. Regis Paper Co.*, New York 17. Operations are expected to reach capacity levels by September.

Detecto Scales, Inc., Brooklyn, N. Y., announces that the following representatives have been appointed in the Detecto-Gram Industrial Div.: *Anchor St. Louis Scale Co.*, St. Louis, Mo.; *Patterson Scale & Equipment Co.*, Jacksonville, Fla.; *C. H. Vilm*, Denver, Colo.; and *R. W. Hooker*, Phoenix, Ariz.

A new and fully equipped grinding school has been established by *Norton Co.*, Worcester 6, Mass. Known as the "Norton School of Grinding", the school offers both the theoretical and the practical approaches to the uses of abrasives and the art of grinding. Basically, the school is designed to teach the practical application of grinding and allied abrasive processes to the company's own sales trainees and plant supervisory personnel, to its distributor salesmen (both domestic and foreign), to customer personnel, and to instructors in grinding from engineering, trade and vocational schools.

United States Gasket Co., Camden, N. J., has appointed *W. S. Shamban & Co.*, Los Angeles, as its exclusive representative for the state of California, offering a complete line of gaskets and packing products, including "Chemiseal" TEFLON.

News of Societies

The *Gray Iron Founders' Society* announces the establishment of an industry-wide contest to determine the most significant and outstanding example of where foundry engineers have redesigned a part or component for production as a casting in place of some other type of construction. All members of the gray iron foundry industry are invited to participate.

Dr. John T. Rettaliata, dean of engineering at the Illinois Institute of Technology, has been named vice president of the *American Society of Mechanical Engineers.*

The *American Society for Testing Materials* awarded Honorary Memberships to six long-time members of the Society, who had given especially meritorious service to it and who were of outstanding eminence in the field of engineering materials. They included Phaon H. Bates, Wilson C. Hanna, Dean Harvey, Prevost Hubbard, Robert Job and Henry S. Rawdon. For the first time, the new A.S.T.M. Award of Merit was presented to nine men, in recognition of outstanding service to the Society, particularly along technical lines and in the technical committees. Those honored included Alfred P. S. Bellis (retired), formerly chief electrical engineer, John A. Roebling's Sons Co.; Harold F. Dodge, quality results engineer, Bell Telephone Laboratories, Inc.; Alan Wade Dow, consulting engineer; Howard P. Ferguson, chief Refinery Control Div., Manufacturing Dept., Standard Oil Co. (Ohio); Daniel W. Kessler, chief of the Building Stone Section, National Bureau of Standards; Thomas G. Stitt, chief inspecting engineer Pittsburgh Steel Co.; T. Smith Taylor, United States Testing Co., Inc.; Percy H. Walker (retired), formerly chief of the Chemistry Div., National Bureau of Standards; and LeRoy L. Wyman, research metallurgist, Knolls Atomic Power Laboratory, General Electric Co.

Harrison D. Goodman and William E. Thompson have both been appointed instructors in mechanical engineering at the *Illinois Institute of Technology.*

The Spirit of St. Louis Medal of the *American Society of Mechanical Engineers* was awarded to Reinout P. Kroon, engineering manager of the Aviation Gas Turbine Div. of Westinghouse Electric Corp. "for leadership in the development of the first American design of a turbo-jet power plant for aviation service". At the same time, Harry Igor Ansoff, associate mathematician with the Rand Corp., received the A.S.M.E.'s Spirit of St. Louis Junior Award for the best paper on an aeronautical engineering subject by a junior member of the Society. The medal and $500 junior award are presented simultaneously at three-year intervals.

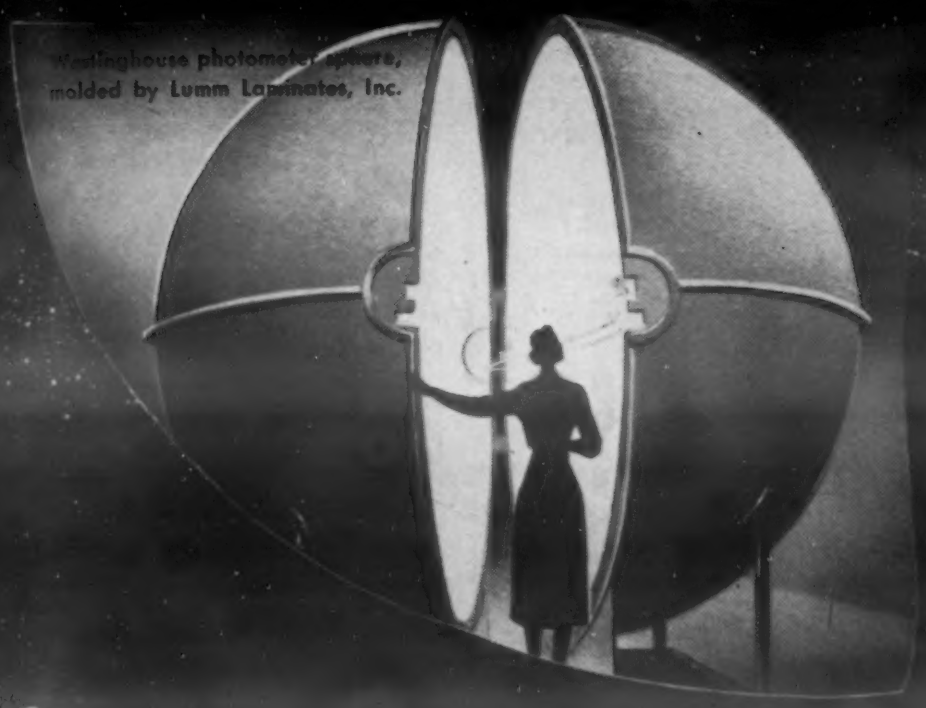
Dr. John Ray Dunning—professor of physics, scientific director of Columbia University's new cyclotron, and a pioneer in atomic research—has been appointed dean of the *School of Engineering* at *Columbia.* Dr. Dunning succeeds Dean James K. Finch, who is retiring from this post due to the age-limit retirement policy, but who will continue to teach, resuming the chair of the Renwick Professor of Civil Engineering, which he formerly held.

Dr. Rolston L. Bond, technical director of the Butadiene Div. of Cities Service Refining Corp., has been named assistant chairman of the Chemistry & Chemical Engineering Dept. at the *Armour Research Foundation* of the *Illinois Institute of Technology.*

News Digest

Commercial Roof Sign molded by Stabilex Ltd., for C. E. Ramsey & Co.

Street-light reflector, molded by Smith & Stone Ltd.



Westinghouse photometer sphere, molded by Lumm Laminates, Inc.

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Products made with LAMINAC® Laminating Resins

Here's what LAMINAC Resins can put into products by way of special performance features:

STRENGTH AND LIGHT... Commercial signs made with LAMINAC Resins are so translucent that *one* electric bulb illuminates them brilliantly. Because of LAMINAC's superior strength, the seller fully guarantees them against breakage under normal use.

LIGHTNESS AND STRENGTH... Five times lighter than one made of iron, and 35,000 times as large as a baseball, the new Westinghouse photometer meets all requirements for strength, ease of handling and maintaining, ease and economy of production.

STAMINA AND LIGHTING... Street lamp reflectors shed light on the toughness and durability of LAMINAC Resins. They offer all kinds of resistance to all kinds of weather, corrosion, and small-boy mischief.

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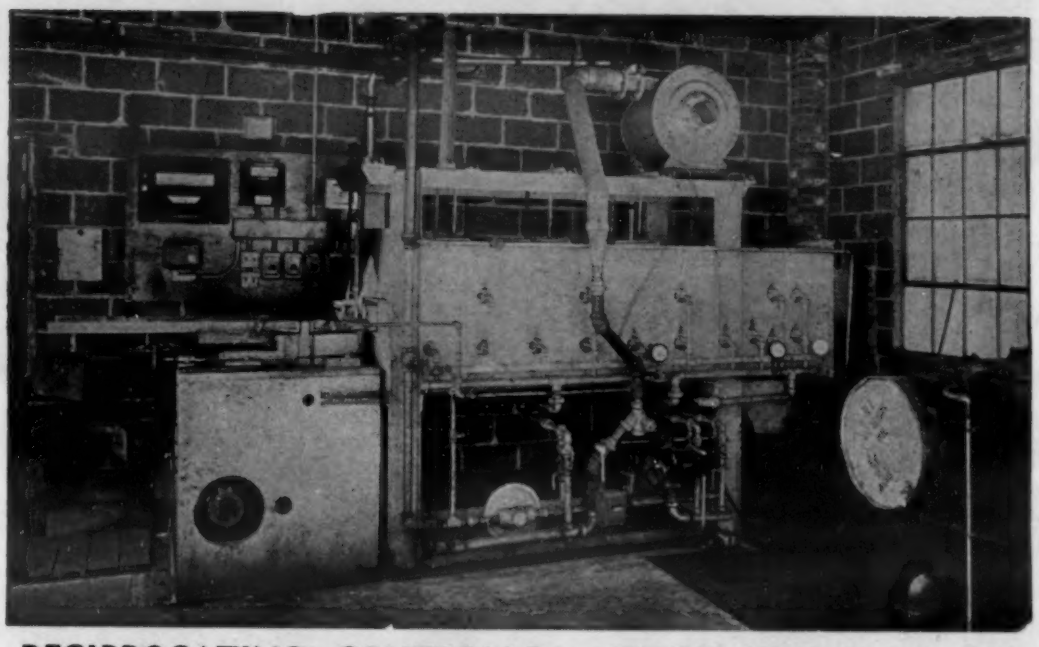

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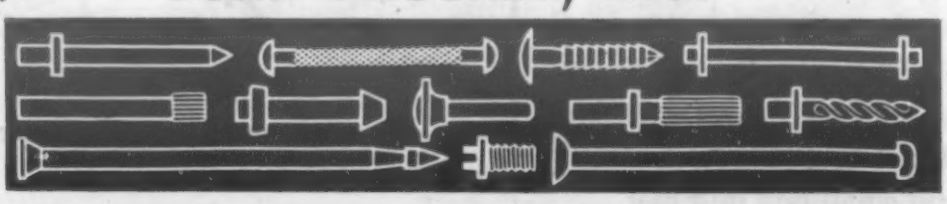
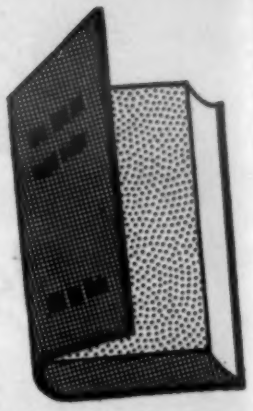




BOOK REVIEWS

Materials Design

THE INELASTIC BEHAVIOR OF ENGINEERING MATERIALS AND STRUCTURES. By *Alfred M. Freudenthal. Published by* John *Wiley & Sons, Inc., New York 16, N. Y., 1950. Cloth, 5¾ by 8½ in., 587 pages. Price $7.50.*

In the preface to this book, the author points out that most of our knowledge concerning the mechanical behavior of engineering materials is derived essentially from phenomenological (large scale) observations. As materials and service conditions become more complex, the volume of experimental work required to provide the empirical "laws" needed in design is becoming unwieldy.

The most effective remedy for this condition, the author believes, would be the development of a more fundamental approach to materials research—an approach based on the analysis of underlying unifying principles. These unifying principles are the laws governing the formation of matter from particles and larger structural elements at different levels of aggregation.

In this book, therefore, the author attempts to present an integrated picture of the response of materials to applied forces, through a combination of structural (physical) and phenomenological (engineering) approaches.

An introductory part discusses the purpose of the study of mechanical behavior and basic concepts and definitions. Parts A and B develop the structural and phenomenological framework of the mechanics of inelastic behavior of engineering materials. Part C deals with specific problems of inelasticity, with design of structures and machine parts under various conditions, and with mechanical testing.

Intended primarily as a textbook for graduate engineering students, the book should also be useful to researchers and designers.

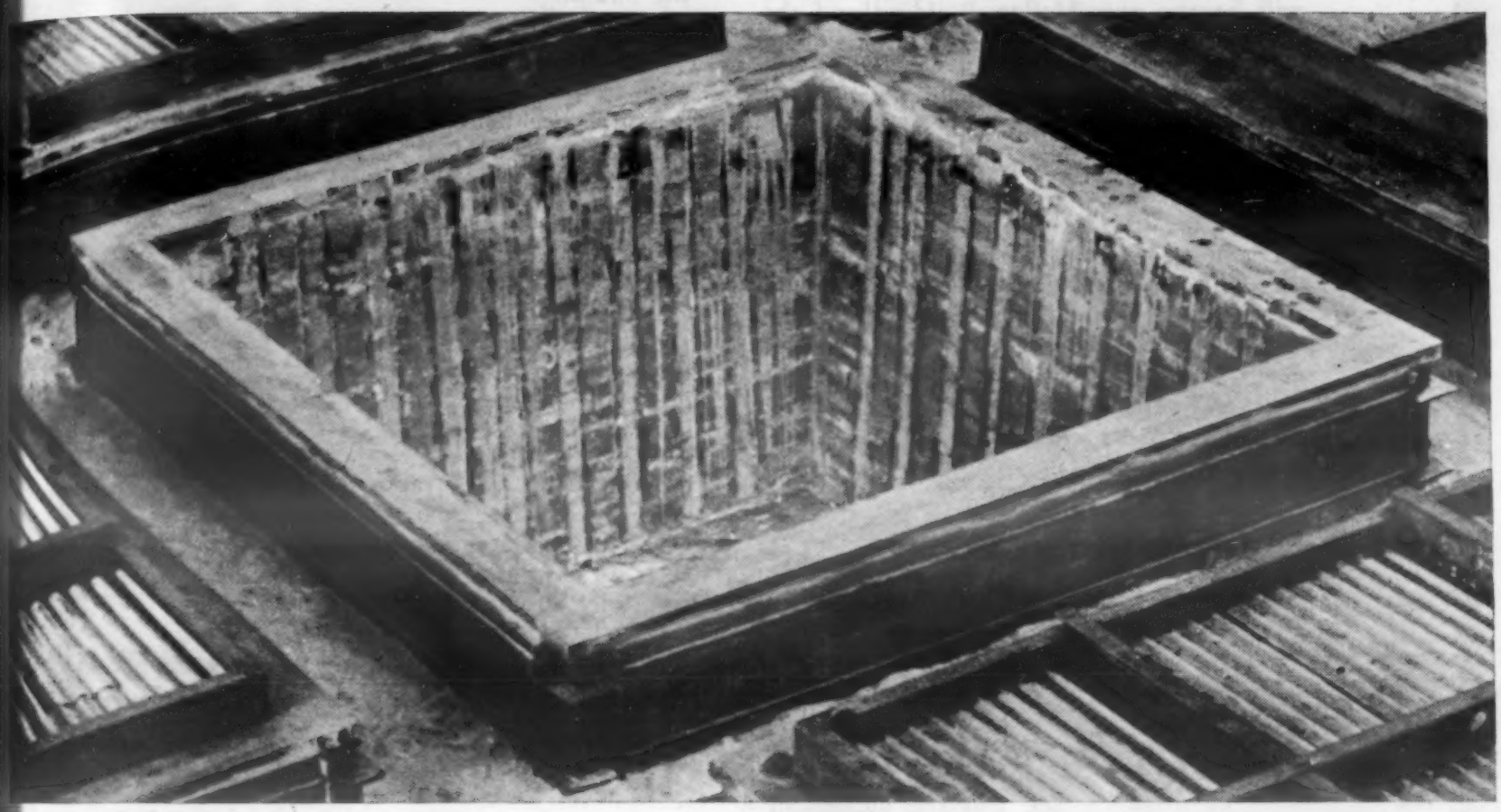
Other New Books

HIGH-FREQUENCY INDUCTION HEATING. Second Edition. *By Frank W. Curtis. Published by McGraw-Hill Book Co., New York 18, N. Y., 1950. Cloth, 5¾ x 8¼ in., 389 pages. Price $6.00.* A practical explanation of an increasingly important technique of applying heat in the production of metal parts. Included is a comprehensive analysis of coil design and timely new material on fixture designs.

SUPERINTENDENT REPORTS:

"5 YEARS OF HARD USE AND NOT A CENT FOR MAINTENANCE"

on these slow-cooling pits made of Lumnite* Refractory Concrete



Nine slow-cooling pits in McKees Rocks, Pa., plant of Carnegie-Illinois Steel Corporation show how monolithic Lumnite Refractory Concrete is used to resist wear and tear at high temperatures. Pits are 14' x 14' x 6', inside dimensions. Walls taper 12" to 20" thick, top to bottom. Built by Rust Furnace Co., Pittsburgh, Pa.

Absorbing sudden thermal shocks as red-hot railroad car axles (often up to 1600°F.) are lowered into them—constantly battered as the heavy axles are charged and unloaded—these slow-cooling pits have required no maintenance in five years.

An unusual case? Not at all. It's typical of many in our files. And the reason is: concrete pits made with Lumnite calcium-aluminate cement and firebrick grog are heat-resisting and jointless. The refractory properties protect against high temperatures; the monolithic walls replace hundreds of small construction units with vulnerable edges and joints which can work loose.

Construction costs are lowered, too. Lumnite Refractory concrete can be placed by unskilled labor. No fitting or trimming of small units, no daubing with mortar. Reinforcing rail-sections are easily built in.

Lumnite is "the adaptable refractory" because, with selected aggregates, it can be cast into any size, shape or thickness. This speeds construction. And when repairs are necessary, they can be made quickly since Lumnite reaches full strength in 24 hours.

Send for further information on time- and money-saving Lumnite Cement. Write to Universal Atlas Cement Company (United States Steel Corporation Subsidiary), 100 Park Avenue, New York 17, N.Y.

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